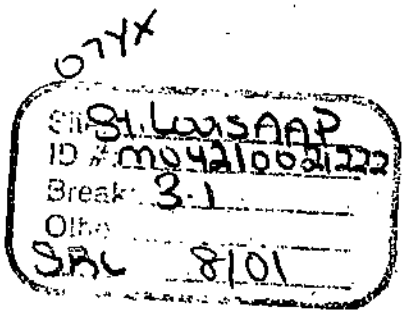
DRAFT

SAMPLING AND ANALYSIS PLAN SITE-SPECIFIC ENVIRONMENTAL BASELINE SURVEY ST. LOUIS ARMY AMMUNITION PLANT ST. LOUIS, MISSOURI CONTRACT NO. DACW41-96-D-8014 TASK ORDER 0019



Prepared for
Department of the Army
U.S. Army Engineer District
Kansas City District
Corps of Engineers
Kansas City, Missouri

August 2001

URS

URS Corporation
10975 EL MONTE, SUITE 100
OVERLAND PARK, KANSAS 66211

Project No. 49-F0K96219.01

U.S. ARMY AVIATION AND MISSILE COMMAND (AMCOM)

ENGINEERING, ENVIRONMENT,
AND LOGISTICS OVERSIGHT OFFICE

ENVIRONMENTAL TEAM
AMSAM-EN
BLDG. 3206
REDSTONE ARSENAL, AL 35898

FAX: COMM (256) 955-0749
DSN 645-0749

TO: Leon Hastings FROM: P Dark

OFFICE: AMCOM-EN PHONE: _____

FAX: _____ DATE: _____

NUMBER OF PAGES INCLUDING HEADER 14

☐ CONTRACTOR SUPPORTING THE MISSION

COMMENTS:

AMC Document
How to forge 105 mm

Jun-00

AMC PAMPHLET

AMCP 706-249

Q 58 16

RESEARCH AND DEVELOPMENT OF MATERIEL

ENGINEERING DESIGN HANDBOOK

312
546-6402
402

AMMUNITION SERIES
N 6, MANUFACTURE OF METALLIC ENTS OF ARTILLERY AMMUNITION

HEADQUARTERS, U. S. ARMY MATERIEL COMMAND JULY 1964

AMCP-
~~Army Mtl Cmd Pam~~ 706-249

PREFACE

This handbook is the last of six handbooks on artillery ammunition and forms a part of the Engineering Design Handbook Series of the Army Materiel Command. Information concerning the other handbooks on artillery ammunition, together with the Table of Contents, Glossary and Index, will be found in AMCP 706-244, Section 1, Artillery Ammunition--General.

The material for this series was prepared by the Technical Writing Service of the McGraw-Hill Book Co., based on technical information and data furnished principally by Picatinny Arsenal. Final preparation for publication was accomplished by the Engineering Handbook Office of Duke University, Prime Contractor to the Army Research Office-Durham for the Engineering Design Handbook Series.

Agencies of the Department of Defense, having need for Handbooks, may submit requisitions or official requests directly to Publications and Reproduction Agency, Letterkenny Army Depot, Chambersburg, Pennsylvania 17201. Contractors should submit such requisitions or requests to their contracting officers.

Comments and suggestions on this handbook are welcome and should be addressed to Army Research Office-Durham, Box CM, Duke Station, Durham, North Carolina 27706.

SECTION 6

MANUFACTURE OF METALLIC COMPONENTS OF ARTILLERY AMMUNITION

INTRODUCTION

6-1. Objectives in Design. Design of components of artillery ammunition seeks to accomplish objectives set forth in requirements of service. Design and the expedients of available material and manufacturing methods must be correlated to minimize drain on stockpiles and man-hours in times of emergency. Principal metals employed for a round of artillery are (1) steel for the shell, (2) brass for the cartridge case, and (3) copper for the rotating band. Steel is also employed successfully for certain types of cartridge cases.

6-2. Reasons for Use of Steel and Brass. The low cost of steel and its ready adaptability to a wide variety of specifications, especially those for strength and hardness, virtually rule out any other material from consideration, as far as the shell is concerned. Cartridge brass, despite its higher cost, owes its traditional employment chiefly to the ease with which it may be drawn into a thin-walled case, its resistance to corrosion, and its successful performance of the function of obturation.

6-3. Selection of Manipulative Techniques. Means employed to cause metals to assume the desired form include (1) casting in a mold; (2) squeezing and drawing, either hot or cold; and (3) machining. Selection of one or more of these techniques, in an appropriate sequence, is governed by considerations of both cost and adaptability. Thus, while it would be possible to machine a large shell out of a solid bar, it is cheaper to forge hot and finish on the lathe. Similarly the easiest way to make a cartridge case is (1) to blank out a disk from rolled strip, (2) to cup it and, (3) by successive draws and intermediate anneals, to extend the metal into a long, cylindrical thin-walled container having the necessary combination of plasticity and resilience to expand with the gun tube at the instant of firing, and to retreat sufficiently to render withdrawal easy. A method of manufacturing cartridge cases by spiral wrapping of sheet steel is also coming into increased use.

6-4. Progress in Manufacturing Techniques. Use is being made of the techniques of powder metallurgy for the manufacture of rotating bands and other parts that lend themselves to this method. Use of cold extrusion methods promises a superior shell body, having the required physical (including fragmentation) characteristics, from a slug which exceeds the weight of the finished carcass by only a few percent. However, throughout the period including the First and Second World Wars, a few changes which could be regarded as radical departures from pre-existing practice took place. Cartridge case manufacture is still more or less unchanged, although the labor of handling components has been greatly reduced. A noteworthy forward step in the case of high-explosive shell was the forge finish of the cavity. This saved much expensive machining.

6-5. Casting Versus Forging of Steel Shells has attracted the attention of many ordnance engineers. The principal resistance to casting high-explosive shells arises from a justifiable skepticism about the integrity of the finished article. Cast steel, except under high hydrostatic heads, is especially prone to blowholes on account of its relatively high melting point, as compared with cast iron. Centrifugal casting has been proposed but never seriously considered. Tank hulls, however, were successfully cast during World War II and the possibility of casting high-explosive shell with the aid of shell molds cannot be overlooked.

6-6. Influence of Hot Versus Cold Work on Steel. In hot-forging, as distinct from cold-working, the temperature of the steel always exceeds the critical range. Hence, the microstructure of the steel is austenitic. No amount

of deformation while in this condition injures the steel in any way; on the contrary, it improves it. Cold-worked steel can always be distinguished from hot-forged stock, under the microscope, by the appearance of the grains. Cold-working tends to elongate the grains whereas hot work breaks up the large crystals, which tend to form at elevated temperatures, into a fine grain of normal polyhedral pattern. However, if steel is subjected to tension while at forging heat, the amount of elongation to which it can be subjected without cracking depends upon the cleanliness of the steel. Dirty steel (including high-sulfur steel), if extended sufficiently under the rolls, may exhibit cracks.

6-7. Hot Work Produces Satisfactory Shell. The familiar pierce-and-draw process of manufacturing steel shells subjects the steel to far less risk of cracking from overextension than the rolling down in the mill. Manufacture of shell forgings by hot work is an eminently satisfactory method. It does entail, of course, the machining of the exterior of the forging and the removal of a considerable quantity of steel. The latter is conserved by circulation through the open-hearth furnances as scrap.

6-8. Influence of Cold Work on Physical Properties of Steel. The principal results of cold work are a considerable increase in tensile strength and a large loss in ductility. Yield strength increases as the cross section is decreased. With reductions of 30 to 70 percent, it is at least 90 percent of the tensile strength; and for greater reductions, yield strength and tensile strength may for all practical purposes be the same. Figure 6-1 shows the stress-strain curves of cold-worked, low-carbon steel. Figure 6-2 shows the influence of carbon content on the gain in tensile strength arising from cold work.

6-9. Extrusion for Shell Manufacture. Steel, especially low-carbon steel, can, it is now known, be made to flow under sufficient pressure into the form of an artillery shell or cartridge case and to acquire, in the process, the required physical properties. Under favorable circumstances pressures of over 200 tons—many times in excess of the yield strength of the steel—may be applied without fear of rupture. Also, deep-drawing operations characteristic of cartridge case manufacture may be

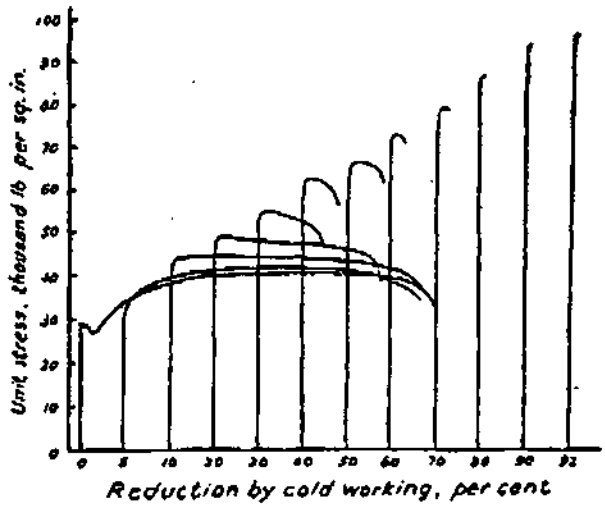


Figure 6-1. Stress-strain curves of cold-worked, low-carbon steel

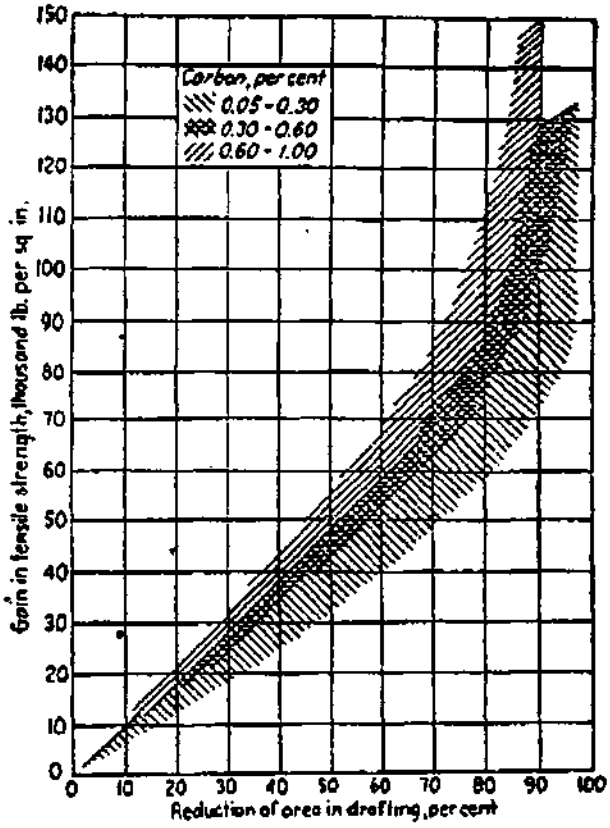


Figure 6-2. Effect of cold working on the tensile strength of carbon steel, gain in tensile strength versus area reduction

carried out to the extent of a 55 percent reduction, an amount far in excess of normal limits.

6-10. Advantages of Extrusion over Forging. Among the advantages claimed for extrusion are (1) the enhancement of physical properties, by cold-work, beyond the requirements of the specifications for steel shell; (2) the elimination of heating facilities for forging and heat treatment; (3) the avoidance of a resort to critical alloys. Manganese content is greatly reduced, savings up to 50 percent being indicated. Further, there appears to be a remarkably low percentage loss of steel in cold extrusion. For example, a 75-mm shell weighing 8.9 pounds starts with a 9.22-pound slug. The key to successful operation lies in the proper application of zinc phosphate to the surface of the shot-blasted and pickled slug and successive squeezes. The metal phosphate acts as a "host" to the sodium stearate soap lubricant to avoid sticking and tearing of the component against the extrusion tools.

FORGING OF HE SHELL

6-11. Steel Used Early in World War II. Shells were forged from a steel known as X-1340, which had the following composition: carbon, 0.35 to 0.45 percent; manganese, 1.35 to 1.65 percent; phosphorus, 0.45 percent maximum; sulfur, 0.075 to 0.15 percent. These are relatively high percentages of manganese and sulfur. High manganese content was originally intended to secure the required physical properties (on cooling from forging temperature) without subsequent heat treatment, manganese being a hardener. The amount by which 0.01 percent manganese increases the tensile strength varies with the carbon content from 100 to 500 psi. The increase in the yield strength is somewhat more than this, 50,000 psi, accompanied by good ductility, being easily attained with manganese in excess of 1.0 percent, provided the cooling is rapid and uniform. While the physical requirements were met in the smaller shells, difficulty was experienced with the 155-mm on account of the higher ratio of volume to heat-robbing surface. This accounts for the decision of the Ordnance Department to adopt a steel with lower manganese content and to obtain the required mechanical properties by heat treatment. This action also saved considerable quantities of manganese, which was in short supply, and simplified the work of the forge by eliminating air-blast cooling; however, the work in the machine shop was increased.

6-12. Objections to High Sulfur Content. Reduction of the manganese content of the steel would have necessitated a reduction in the sulfur in any event, since there is a limit to the amount of sulfur with which manganese will combine to form manganese sulfide and thus rid the steel of the more objectionable iron sulfide. Lower percentages of sulfur were desirable, however, for other reasons. First, manganese sulfide is almost completely insoluble in solid iron. Consequently, when the iron solidifies manganese sulfide is present in the mass of metal as discrete particles. These particles, if present in large quantities, as a result of excessive sulfur, may have a deleterious effect on the ductility and impact resistance of the steel. In general, as far as steel for shells is concerned, high sulfur content was believed (1) to contribute to nonuniformity in quality; (2) to be responsible for transverse weakness and red shortness, giving rise to longitudinal cracks at the open end of the shell; and (3) to occasional surface defects. High sulfur content does, however, promote free machining. But above all other considerations, the presence of large quantities of high sulfur shell-steel scrap (crop ends, scrap forgings, lathe chips, etc.) was a menace to the quality of other steels in the mill whose sulfur contents were normal.

6-13. Steels Used After World War II. Steel which replaced the older X-1340 had the following composition: carbon, 0.60 percent maximum; silicon, 0.15 to 0.35 percent; manganese, 1.00 percent maximum; sulfur, 0.06 percent maximum. Maximum percentages of residual ingredients were given as follows: nickel, 0.35 percent; chromium, 0.30 percent; copper, 0.25 percent; together with the proviso that the sum of the percentages of nickel, chromium and copper must not exceed 0.50. This steel had no noticeable influence on the amount of work required in the forge shop. There was a noticeable absence of any tendency to crack, especially at the open end of the forging. The work of the machine shop, however, was increased.

6-14. Prevailing Shell Steel Specifications. The chemical requirements of shell steels, as of 17 February 1953, are shown in table 6-1.

Grades WDSS 1 and 2 are used for the most part for 60-mm and 81-mm mortar shell forgings; also for the 57-mm recoilless gun shell. The other grades cover all calibers from 37-mm to over 155-mm, in which the yield strengths vary from 60,000 psi to 80,000 psi. All shell steel is made by the basic open-hearth process to fine grain practice, silicon 0.15 to 0.30 percent. Bessemer steel never has been acceptable for shell bodies because of its low notch toughness, especially at subzero temperatures. The current specification for hot-forged artillery shell is identified as MIL-S-10520C (ORD).

Table 6-1

Steel no.	Carbon percent	Manganese percent	Phosphorus percent	Sulfur percent	Silicon percent
WDSS 1	0.14-0.20	1.00-1.30	0.040 max.	0.08-0.13	0.10 max.
WDSS 2	0.28-0.34	0.60-0.90	0.040 max.	0.050 max.	0.15-0.30
WDSS 3	0.60 max.	1.00 max.	0.040 max.	0.050 max.	0.15-0.30
WDSS 5	0.55 max.	1.00 max.	0.040 max.	0.050 max.	0.15-0.30
WDSS 6	0.55 max.	1.00 max.	0.040 max.	0.050 max.	0.15-0.30
WDSS 7	0.65 max.	1.30 max.	0.040 max.	0.050 max.	0.15-0.30

In the above steels, incidental elements shall not exceed the following: nickel, 0.25 percent; chromium, 0.20 percent; copper, 0.50 percent; molybdenum, 0.06 percent.

6-15. Shapes From Which Shell Forgings Are Made. The modern hot-forged shell blank starts as a billet, parted off from round stock or square stock with rounded corners. In the familiar pierce-and-draw process, the square-stock type has the advantage (more fully discussed elsewhere) of imposing less severe duty on the punch, since lateral movement of the steel takes place as the die pot is filled, thus limiting the extent of rearward extrusion.

6-16. Specifications. Military specification for shell steel covering the compositions shown in the table above are the following.

Federal. QQ-M-151 — Metals: General Specification for Inspection of.

Military. MIL-M-11286 — Macroetch Test and Macrographs of Steel Bars; MIL-M-12286 — Macroetch Test and Macrographs for Resulfurized Steel Bars, Billets and Blooms.

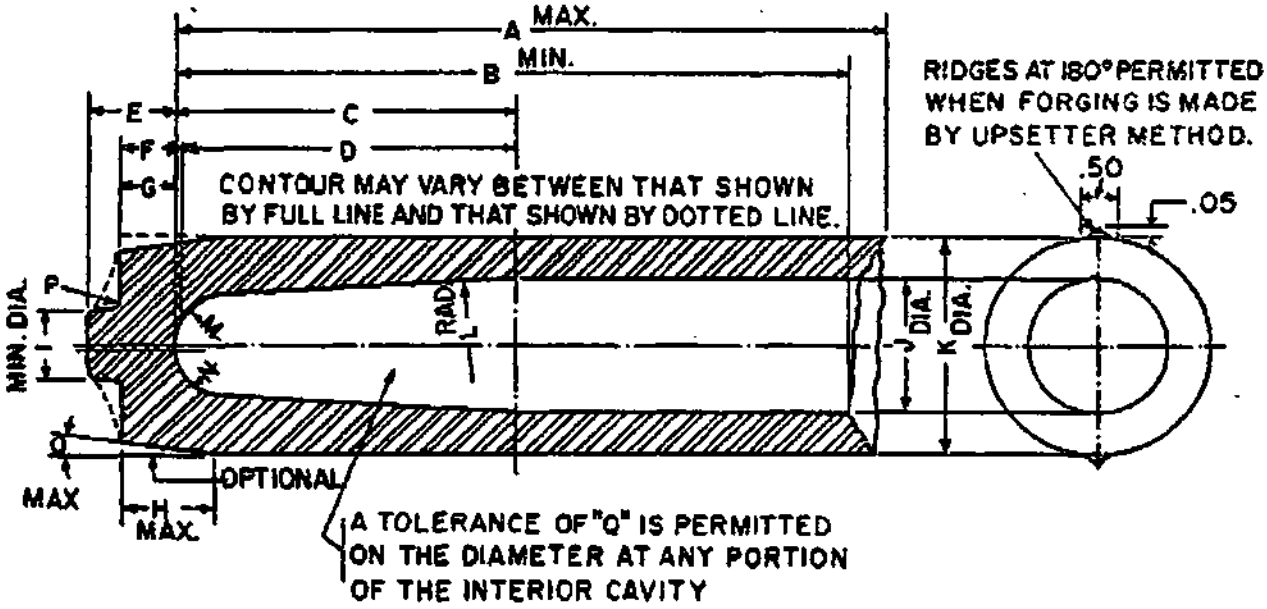
Standard. Military, MIL-STD-129 — Marking of Shipments.

These specifications (1) cover the quality of the steel; (2) indicate permissible variations for check analysis; and (3) deal with the matters of internal soundness, (4) extent of the discard from the top and bottom of the ingot, (5) identification by heat number, and (6) surface condition. They also exhibit permissible variations from size and straightness; and deal with sampling, inspection, and test procedures. Notes are also appended on preparation for delivery and ordering data.

6-17. Shapes and Dimensions of Shell Forgings. Figure 6-3 gives information on the shape and dimensions of forgings for 75-mm, 90-mm, and 105-mm shell. These data were laid down for World War II manufacture. The dimensions shown were standardized at a time when the Ordnance Department purchased shell forgings from prime contractors. Later on, when shell machiners purchased shell forgings directly from the forge plants, no fixed outside dimensions existed. In consequence the same shell forger made shell forgings to different dimensions at various times, or even at the same time, if he had orders from several shell machiners. The desirability of saving weight caused changes in these dimensions to the point where they lost their original significance. Cavity sizes, of course, persisted, since the cavity was finished in the forge, apart from the small amount of material removed by shot blasting.

6-18. Billet Separation. The great majority of shells are forged from single or double slugs parted off from the main billet or bar. Separation may be effected in various ways, especially by (1) shearing, (2) sawing, or (3) flame cutting; (4) "nick and break" was also widely used. The first three do not permit effective inspection of the separated surfaces for secondary pipes, cracks and holes. Breaking does, but slivers and rough breaks occasionally mask holes and cracks. Moreover, steel breaks at times with a loose sliver which is not easily detected if it lies flat against the broken surface. Such a sliver would end up as a sliver in the cavity and be detected on shot blasting, causing rejection of the forging.

For shearing, the bar must be heated to at least 80°F to avoid shearing cracks. Even so, if the slugs are not delivered to the furnace within a few hours or days at the most, cracks may develop unless the steel has been heated to 200°F. Among the methods available for



SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
75mm	13.125	11.35	5.51-20	5.48-20	1.36	1.11	1.08	1.4	1.06	2.13	3.28-.06	24	.8	.47	8°	.1	.002
90mm	14.0	1230	6.30-	6.11-20	2.15		1.43	1.5	1.25	2.55	3.92-.08	4	.8		6°	.1	.025
105mm	19.0	15.5	8.45-20	8.60-20	2.25	1.65	1.30	2.0	2.00	3.30	4.55-10	18	1.25	.5	8°	.25	.025
155mm	26.50	23.0	10.42-25	10.10-25	2.80	1.90	1.58	3.0	2.50	4.84	6.60-10	43	1.75	1	8°	.25	.035

DIMENSIONS OF SHELL FORGINGS

Figure 6-3. Dimensions of shell forgings

separation of the slugs from the bar, shearing is the cheapest. However, shearing of rounds is limited to 3 inches diameter, although somewhat larger squares are sheared. Nicking and breaking is the cheapest method for large shells. Sawing and flame cutting give square ends that make it easier to set the slug upright on the rotary hearth of the heating furnace.

6-19. Billet Scale and Descaling. Shell steel bars, when delivered to the forge, are covered with a light scale and occasionally with rust. The amount of scale formed and its nature vary with furnace heating time, temperature, and the composition of the shell steel and of the furnace atmosphere. Scale is abrasive and ruins tools and dies. A nonretentive scale is desired, that is, one that can readily be knocked off in its entirety. Scale on a round slug can be cracked off with an end squeeze; another method employs serrated rolls. Water jets driven by high pressure (2,500 psi) are effective without appreciable cooling effect. A thin skin only is affected in the second or so of contact between high-pressure water and the steel. Reheating of the thin, cooled skin by the heat in the body of the slug is rapid.

6-20. Shell Forging. The apparently simple process of forging a shell from a heated slug is actually beset by many pitfalls. Modern techniques have grown out of extensive development. Earlier and more direct methods centered about forcing a punch into a round slug previously raised to forging heat and placed in a die or "pot" which it fitted loosely. The metal rises around the punch, much after the fashion of drawing on a heavy steel glove. The load on the punch under these circumstances is very severe, and its life is short. The surface of the punch deteriorates rapidly, giving rise to rough cavities which have to be machined. "Wash" heating of the slugs (hasty heating causing steep temperature gradients from the hot exterior to

the cooler interior) forces the punch to run to the side, producing "thick-and-thin" forgings, difficult to machine and wasteful of steel.

Punches are now made of alloy steel and are lubricated. The load on the piercing press is reduced by performing the forging process in two steps. First a cup is formed in the press; this cup is then mounted on a mandrel and pushed through a series of ring dies of gradually diminishing size to draw out the body of the forging.

Possibly the most significant change between the two World Wars has been the use of round-cornered squares in place of rounds for the slugs. The load on the punch is reduced, since lateral flow of the steel to fill the die reduces the amount of backward extrusion, as well as the work required to change the shape of the slug to that of a cup.

6-21. Objectives in Shell Forging. The effort to produce accurate, minimum-weight shell forgings arises from the necessity of saving steel. During a war, shells are manufactured in astronomical quantities, and demand on steel capacity is correspondingly heavy. The return of scrap and chips to the mills reduces the load on the blast furnace, and is a necessary part of the material requirement of the open hearth. Transportation is another factor. Tools need be conserved. Power used in the machine shop is less if only a thin roughing cut has to be made. Weight may be saved at the outside diameter, also on the length and on thickness at the base. But enough metal has to be left to make sure that a high percentage of forgings will "clean up" during rough turning without leaving any black spots.

Several distinct improvements have been successful: (1) the so-called French extrusion process, in which a plunger moving downwards within a cylindrical die extrudes the slug over a punch which sits upright with its nose within the die; (2) use of mechanically operated presses, such as bulldozers and upsetters; (3) application of cross rolls (familiar in the manufacture of seamless tube) to the extension of the cup produced by the piercing press; (4) the "one-shot" process, in which the base of the die drops downwards under a controllable pressure, thus minimizing rearward extrusion of the steel and relieving the load on the punch.

6-22. The One-Shot Method. Figure 6-4 illustrates diagrammatically the progressive stages in the one-shot piercing process that is credited with producing smooth, satin-like cavities. The profile of the piercing punch must, of course, be that of the cavity in the shell. Since the ordinary high-explosive shell has a fairly large length-to-cavity diameter ratio, the piercing punch is much longer and more slender than the punch required for the more familiar double-operation sequence of pierce and draw. Provision of a retreating base in the die averts the limitations encountered when shells were pierced in one go.

In the one-shot process, friction between the exterior of the slug and the die tends to hold the forging against the die walls, while the punch makes its way into the interior of the slug, extending it as the base of the die drops when the thrust upon it exceeds a predetermined adjustable value. Slug temperatures must be high and heating should be uniform if "run-out" of the long and relatively slender punch is to be avoided. A modification of the one-shot process calls for the use of a second press where the bottom of the forging is set.

Figure 6-5 is a diagrammatic cross-section through a "one-shot" press. The piercing punches are fastened to a turntable which is indexed 90° after each piercing operation. This gives the punches a chance to cool off and to be lubricated for the subsequent operation. After the first turn through a right angle, the punch which has just been at work is sprayed with oil. Another quarter turn and it is immersed in oil. A third quarter turn and it is in the inspection position. The means whereby the base of the die (marked "resistance pin") descends as the pressure upon it exceeds a predetermined pressure are clearly in evidence. This relief pressure is adapted to the variable resistance of shell steel at forging heat to change of shape; and to variations in the frictional resistance of the interior of the die with wear. Punches in this operation have to be carefully guided, as indicated by the extensive punch guide on top of the die.

6-23. Hydraulic Piercing for Subsequent Drawing. In the process described in the preceding paragraph, the entire action takes place in the piercing die unless a second operation to set the bottom of the forging is used. The greatest

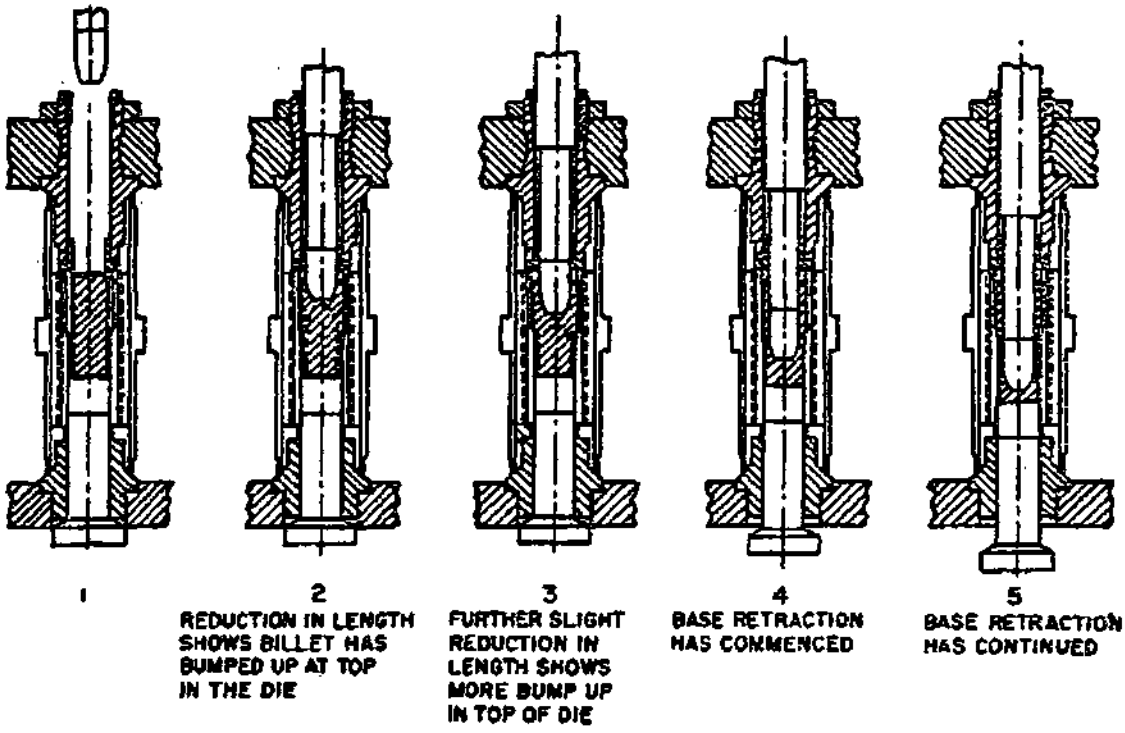


Figure 6-4. Progressive stages of one-shot piercing method

part of high-explosive shell manufactured during World War II, however, was forged in two major operations, the "pierce" and the "draw". Many minor variations of the piercing or "cupping" operation appeared. Sometimes the die pot was inverted, the punch entering from below, partly to facilitate the removal of scale but principally to secure concentric entry of the punch. If a cylindrical or prismatic slug is placed in a tapered die set upright, it tends to rest against one side of the die, causing eccentric entry of the punch. There is less liklihood of this happening in the case of an inverted die. Figure 6-6 shows the arrangement of the tools of a hydraulic press for inverted piercing.

6-24. Round Versus Square Slugs. During World War II the use of round stock for shell slugs was restricted, on account of its higher cost as compared with round-cornered square billets. But there is less rearward extrusion, that is, flow of metal in the direction opposite to that of punch travel. In fact, in the early use of the round-cornered square it was hoped to avoid rearward extrusion (with its consequent erosion of punch and die) by making the area of the original square equal to that of the final annulus. Actually the slug is shortened by the pressure of the punch until friction between die and slug takes hold and lateral displacement supervenes. Finally the excess metal in the die extrudes rearward toward the end of the piercing stroke.

The maximum square is determined by the consideration that the steel displaced from the cavity by the punch must be sufficient to fill the four segments between the billet and the die; otherwise the forging would not fill the die. If S is the measure of the side of the square and r the radius of the corner, then for equality between the area of the original round cornered square and the final annulus

$$S^2 = 3.222rS + 2.45\,r^2 = 1.375d^2$$

6-25. Drawing After Piercing. Figure 6-7 exhibits a typical draw bench with solid ring dies. As previously indicated, the forge work required to produce a shell is divided between the piercing press and a subsequent draw. The drawing operation may be carried out on a mandrel which pushes the cup through a series of ring dies of successively smaller diameter. Instead of solid rings, rollers may be used; or humped rolls may be employed for the purpose,

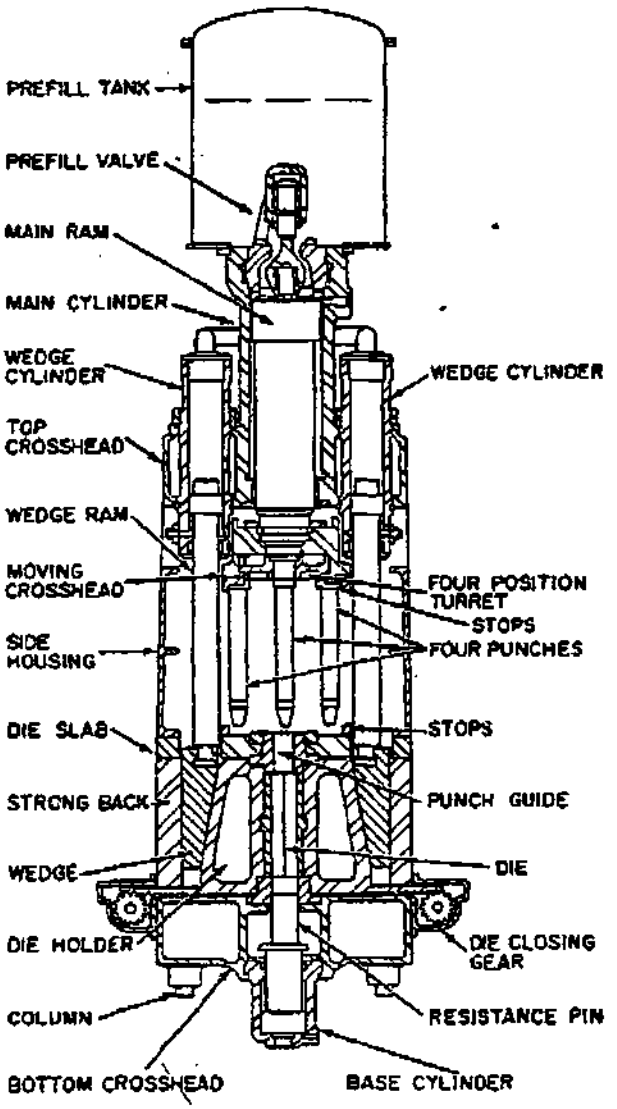


Figure 6-5. One-shot press

as shown in figure 6-8. While the shape of the piercing punch is determined by the experience of the tool designer, the profile of the drawbench mandrel must, of course, be that of the cavity in the shell. Likewise the diameter of the last ring die is determined by the diameter of the shell, that is, it must not be less than this. Actually, of course, sufficient metal must be left on the outside to "clean up" on machining. The cavity is merely shot-blasted, and little metal is removed in the process.

6-26. The French Extrusion Method of forging shell foreshadows the modern techniques of cold extrusion which will be described later. The principle is illustrated in figure 6-9. A slug, raised to forging heat, is placed in the die (B). The punch (C) then moves forward to cause flow through the annular space between the die (B) and the mandrel (A), the action being continued until the desired base thickness of the forging is secured. The process can be readily carried out on a bulldozer. This simple method of forging high explosive shell attracted less attention during World War II than it merited, partly on account of the uncertainty concerning the outside diameter of the forging. Some care is necessary in the adjustment of the relative axial position of the die (B) and the mandrel (A), and consequently of the characteristics of the annular orifice between them, to ensure satisfactory performance.

6-27. Progressive Piercing on the Upsetter. The origin of the force that does the work in forging a shell from a slug is a matter of little moment, granted that adequate force is available. A hydraulic press produces a steady thrust, but a crank and flywheel combination produces a variable thrust. The thrust may be as great near the dead center as the several parts of the machine will withstand, but it declines rapidly toward crank positions at right angles to the dead center.

Given a sufficiently powerful press, the job of forging a shell should apparently be completed at one heavy stroke; nevertheless, a series of operations is necessary, if for no other reason than that the energy capacity of the system per revolution of the flywheel is a limiting factor. The sequence is best interpreted by reference to figure 6-10, entitled "Upsetter Forging With a Collar." In brief, the bar, one end of which has been heated while the other serves as a tong hold, is pushed against a stock gage and gripped by the closing dies. In the first push (not shown in the diagram) the punch upsets the end of the bar and splinters the scale. Thereafter, the stock is pushed forward to the gage a second time after turning through 90°. Subsequent events may be followed from the diagram. After each thrust of the pitman carrying the head in which the punches are mounted, the

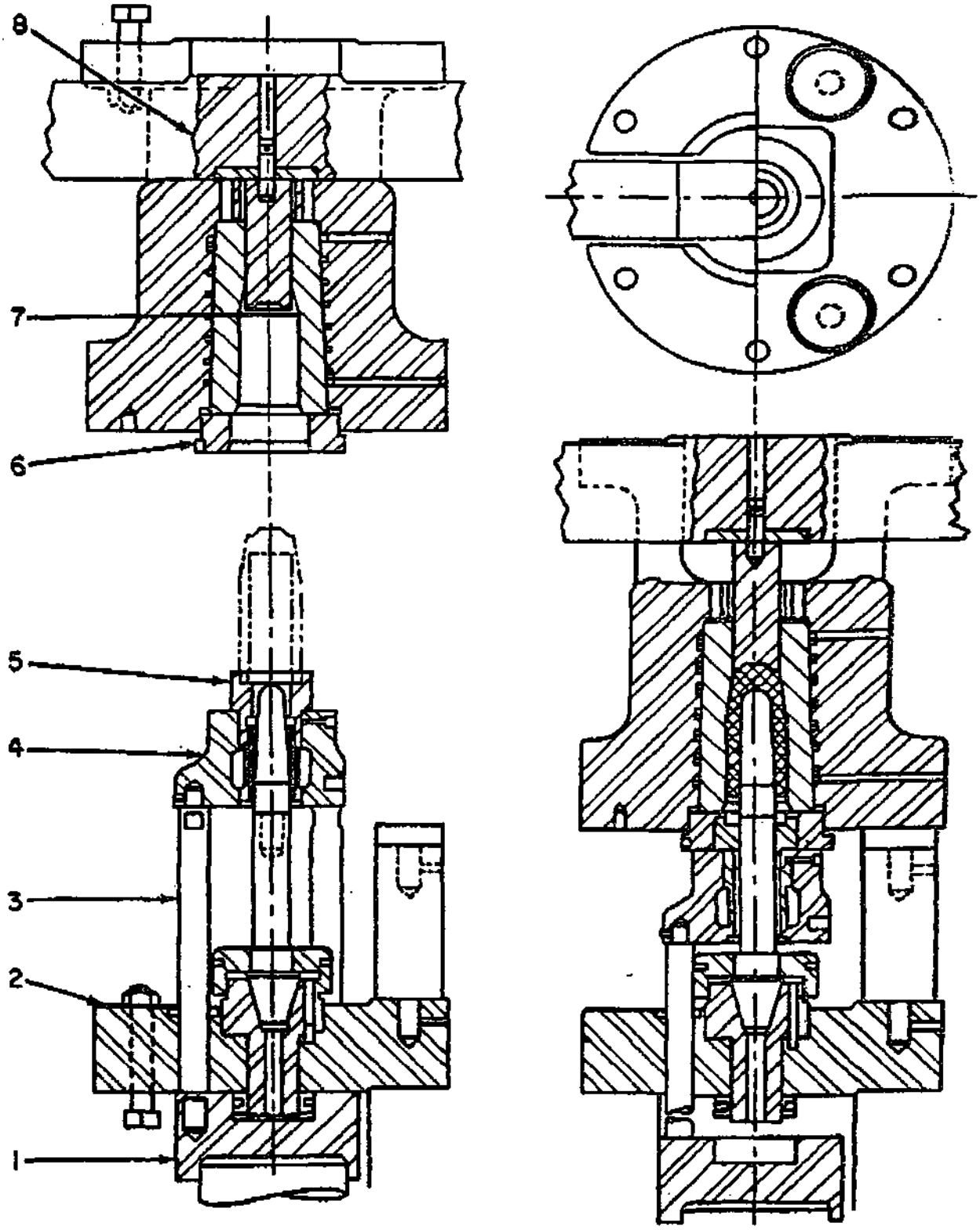


Figure 6-6. Hydraulic press tools

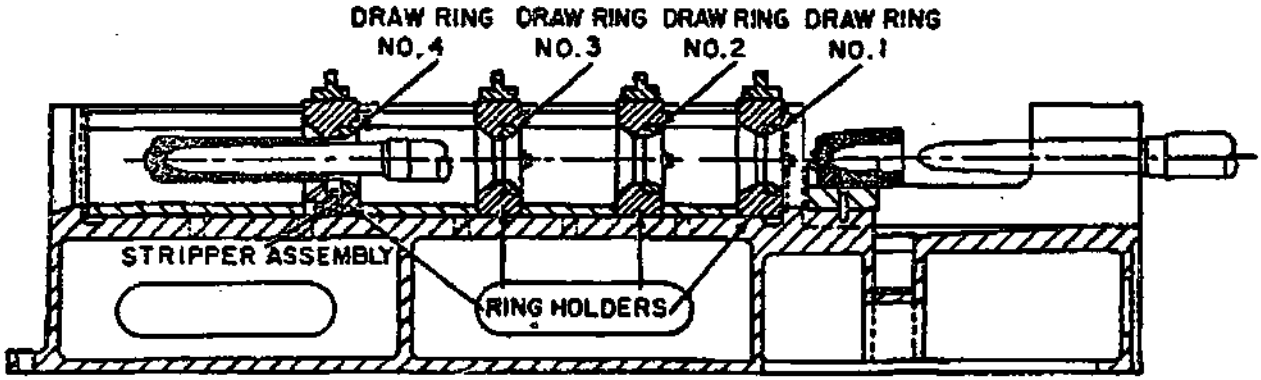


Figure 6-7. Draw bench

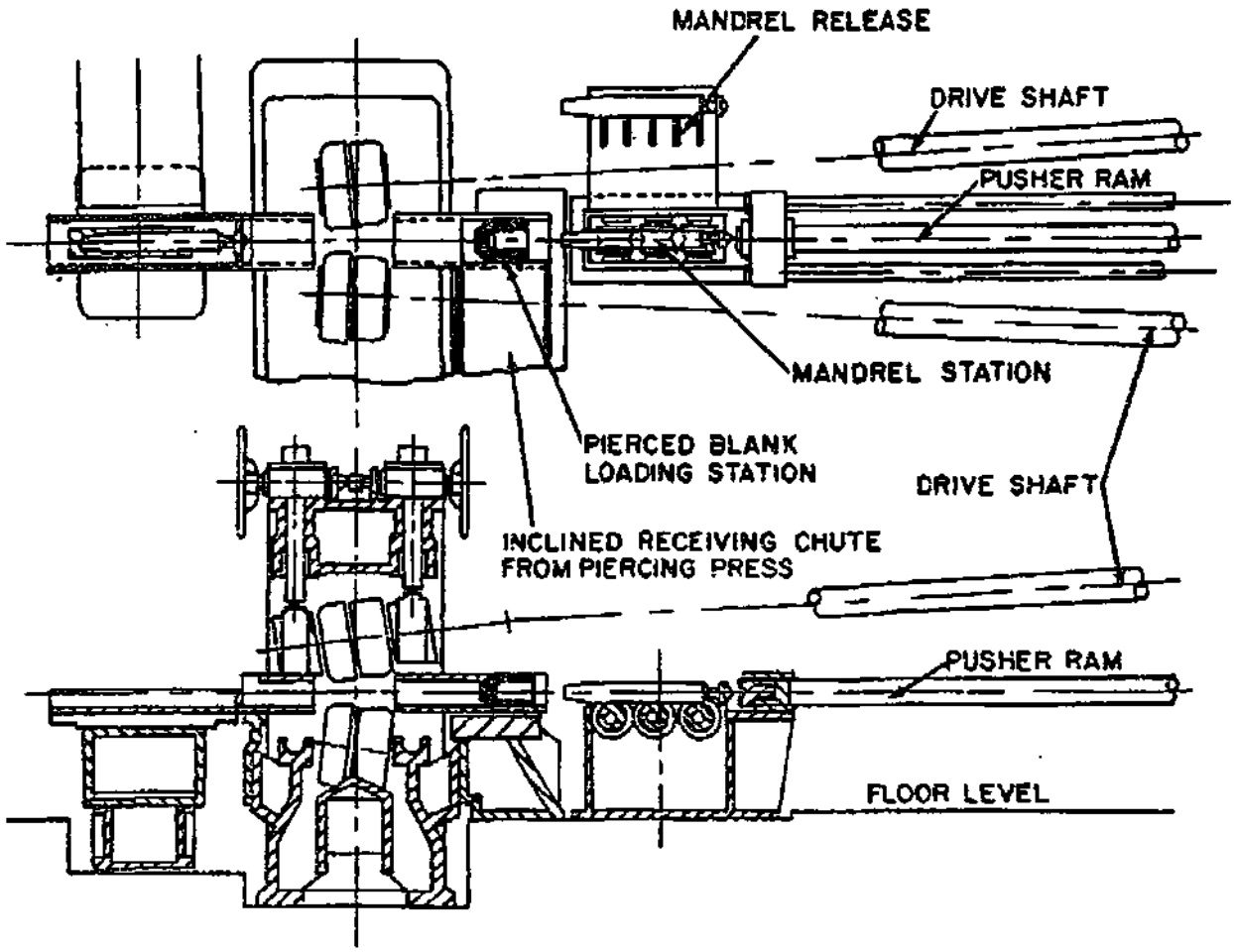


Figure 6-8. Cross rolling mill

split die opens, one half moving under toggle action to enable the operator to transfer the stock from one impression to the next below. In this way the final form of the forging is reached. Round or square stock may be used in the upsetter. The latter has the advantage of being readily gripped in the dies, despite reasonable variations in size.

6-28. The Effect of Water Sprays on Hot Forgings lies in the extent to which the hot forging is cooled. With modern shell steels, no injury results as long as the outer layers remain above the critical temperature; however, if surface cooling is continued until the temperature falls to the "blue heat" (around 700°F), the deformability of the steel becomes low; steel tends to fracture at this temperature like cast iron. Ordinarily this does not happen. Even the hydraulic descaling of the slug with cold water under a pressure of 2,500 psi appears to have no injurious effects. In any case,

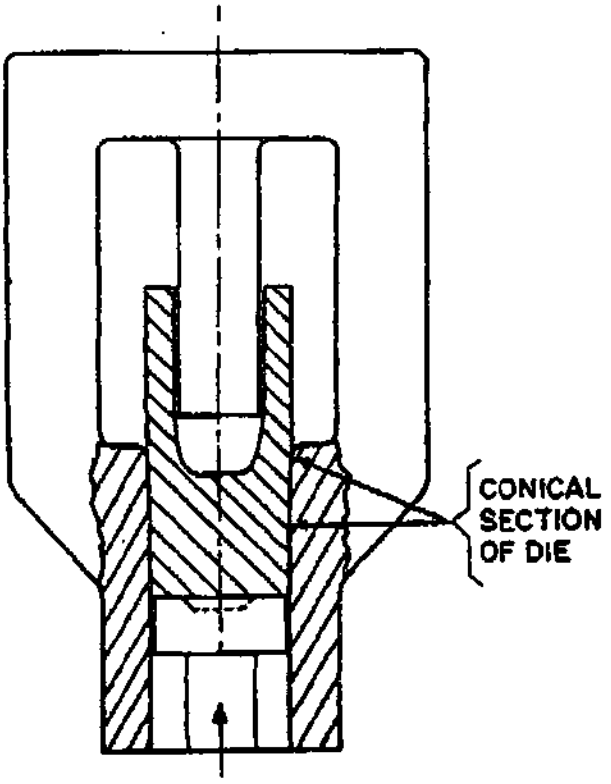


Figure 6-9. French extrusion process

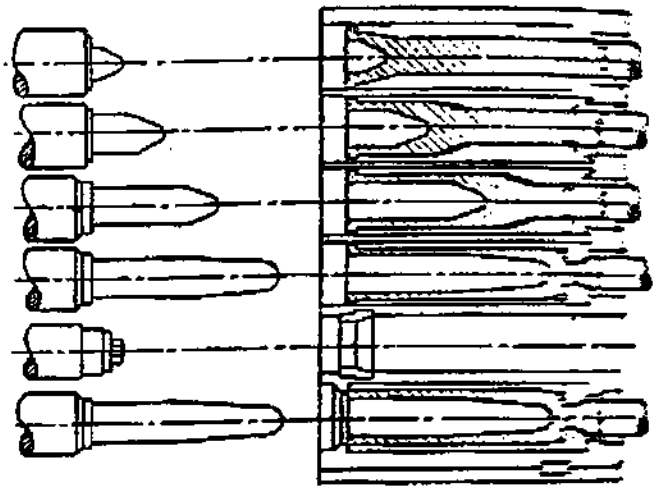


Figure 6-10. Upsetter forging

even if fine hair-like cracks should form on the outside of the forging, any injury from water would be removed in rough turning.

Cracks in the cavity would be more serious, both because of the greater difficulty of observation and on account of the small amount of metal removed by shot blasting. Careful investigation, in cases where water was freely sprayed in the cavity for periods in excess of normal, failed to reveal any cracks from this cause.

6-29. Economics of Shell Forging. The cost of producing a usable shell forging is the sum of many minor and a few major items. These include the cost of the steel, freight, unloading, billet separation, transportation to furnace, heating, descaling, forging, cooling, inspection, hospitalization, and loading. Coupled with these costs are those for supplies, such as fuel, refractories, material for tools, packings, lubrication, overhead in the form of interest, depreciation of buildings and equipment, insurance, taxes, management and other forms of indirect labor; all of these must also be included in cost appraisal.

In making an appraisal of the different techniques of forging shell, the method which proves most economical for one size of shell may not be the cheapest for another. For example a 75-mm HE shell forging is most

economically made on the upsetter; the upsetter, however, is the most expensive method of making the 105-mm.

6-30. Comparative Study of Shell Forging Methods. Certain considerations other than cost enter into the selection of equipment to forge shell. These are (1) what type of equipment is best adapted to rapid conversion on the outbreak of war; (2) what forging equipment should be immediately available, without conversion, if urgent necessity should arise; (3) the degree of skill required in any given method, since a process than can be operated by unskilled labor has the advantage of a quick start.

An ASME study on "The Forging of H.E. Steel Shells" tabulates the various items of cost entering into the manufacture of 720,000 shells by various methods, for four different sizes of shells, namely, 75-mm, 90-mm, 105-mm, and 155-mm. The figures relate to 1943. In the final analysis no large differences, with one or two exceptions, exist among the various methods. Total cost divided by number of shells results in the following average dollar values of the four shell sizes:

For the 75-mm shell forging,
577,500/720,000 = $0.81
90-mm shell forging,
877,800/720,000 = $1.22
105-mm shell forging,
1,188,600/720,000 = $1.65
155-mm shell forging,
3,443,000/720,000 = $4.78

Slug weights for these shell sizes were, approximately, 19, 30, 42, and 128 pounds, respectively. The costs per pound of forged shell are:

4.3 cents for the 75-mm
4.1 cents for the 90-mm
3.9 cents for the 105-mm
3.7 cents for the 155-mm

Certain items, such as real estate and buildings, taxes, burden, overhead, and other more or less fixed expenses, are not included in these figures.

6-31. Inspection of Shell Forgings. Forgings are inspected for soundness and adherence to dimensions. Inspection procedures fall into the following categories:

1. Inspection for Soundness.
   Soundness of base
   Seams and slivers
   Scoring or roughness of cavity
   Scale pits
   Gas pockets or blisters
   Torn cavity
   Tear drops
   Cracks in nose end after nosing
2. Inspection for Adherence to Dimensions.
   Outside diameter
   Diameter of cavity
   Length of shell (clean metal)
   Thickness of base
   Eccentricity
   Ovality
   Length of taper in cavity
   Ballooning of cavity (double nose)

6-32. Inspection Before Heating. The principal defects encountered in the slug are (1) unsoundness of the center caused by pipe; and (2) surface seams and laps. Pipe is an unusual extension of the cavity which forms under the upper crust as the ingot cools and shrinks. This defect is usually removed by cropping in the mill; but incomplete removal may cause unsound cores and basal porosity. Shells are protected against premature detonation from this cause by a rolled steel plate, welded to the base. Experiments to determine the possibility that basal porosity will cause detonation within the gun tube indicate that the risk is very small. It is, however, a chance that cannot be taken. Pipe is detected by sawing and macroetching the ends, and sometimes the middle, of the bar. Billets 5 by 5 inches, or larger, are particularly subject to unsoundness, hence the ends of each slug are usually examined.

6-33. Inspection After Forging. Inspection after forging is done before the forging has cooled. The principal checks are made for concentricity and thickness of base. This is followed by a cold inspection prior to machining. "Tear drops" and "torn cavities" arise from the same cause. The melting point of the steel skin in the cavity is lowered by the addition of the carbon in the graphite lubricant used on the punch, and may liquefy in flakes or globules which weld themselves to the wall of the cavity. The bond is not secure. The shot blast sometimes removes the flakes and the tear drops may be chiseled out.

DRAFT

PART I
FIELD SAMPLING PLAN
SITE-SPECIFIC ENVIRONMENTAL BASELINE SURVEY
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
CONTRACT NO. DACW41-96-D-8014
TASK ORDER 0019

Prepared for
Department of the Army
U.S. Army Engineer District
Kansas City District
Corps of Engineers
Kansas City, Missouri

August 2001

URS

URS Corporation
10975 EL MONTE, SUITE 100
OVERLAND PARK, KANSAS 66211

Project No. 49-F0K96219.01

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

TABLE OF CONTENTS

Appendices

LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS

ACM	Asbestos Containing Material
AMCCOM	U.S. Army Armament, Munitions, and Chemical Command
AMCOM	U.S. Army Aviation and Missile Command
ASTM	American Society for Testing and Materials
ATCOM	U.S. Army Aviation and Troop Command
AVSCOM	U.S. Army Aviation Systems Command
bgs	below ground surface
BRA	Baseline Risk Assessment
CALM	Cleanup Levels for Missouri
CCTV	Closed Circuit Television
CENWK	Kansas City District, USACE
CEWES	U.S. Army Corps of Engineers, Omaha Laboratory
COC	Chain-of-Custody
COE	Corps of Engineers
CQAB	Chemistry Quality Assurance Branch, USACE
CQC	Chemical Quality Control
DCQCRs	Daily Chemical Quality Control Reports
DoD	Department of Defense
DQOs	Data Quality Objectives
EBS	Environmental Baseline Survey
EM	Electromagnetic
EPA	U.S. Environmental Protection Agency
FOST	Finding of Suitability to Transfer
FSP	Field Sampling Plan
gpm	gallons per minute
IAG	Interagency Agreement
IDW	Investigation Derived Waste
LBP	Lead Based Paint
LIMS	Laboratory Information Management System
MDLs	Method Detection Limits
MDNR	Missouri Department of Natural Resources
NON	Notice of Noncompliance
NRD	Natural Resources District
PCB	Polychlorinated Biphenyl
PFE	Plant Facilities and Engineering, Inc.
PPE	Personal Protective Equipment
PRG's	Preliminary Remediation Goals
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SEMCOR	Titan Systems Corporation, SEMCOR Division
SHERP	Safety, Health, and Emergency Response Plan
SLAAP	St. Louis Army Ammunition Plant

LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS

SLOP	St. Louis Ordinance Plant
SMPRO	Site Manager Pro®
SSEBS	Site-Specific Environmental Baseline Survey
SVOCs	Semi-volatile Organic Compounds
TTEMI	Tetra Tech EM, Inc.
USGS	U.S. Geological Survey
URS	URS Group, Inc.
USACE	U.S. Army Corps of Engineers
UST	Underground Storage Tank
VOC	Volatile Organic Compounds

1.1 BACKGROUND

The purpose of this Field Sampling Plan (FSP) is to establish the sampling strategy, sample locations, and the procedures and protocols to be followed during implementation of site-specific environmental baseline survey (SSEBS) at the St. Louis Army Ammunition Plant (SLAAP) located at 4800 Goodfellow Boulevard in St. Louis, Missouri. This document was prepared on behalf of the U. S. Army Corps of Engineers (USACE), Kansas City District and the U.S. Army Aviation and Missile Command (AMCOM), Huntsville, Alabama under URS Contract number DACW41-96-D-8014, Task Order 0019.

This FSP constitutes Part I of the Sampling and Analysis Plan (SAP). Part II of the SAP is the Quality Assurance Project Plan (QAPP). This FSP is organized into eleven sections and the contents of each section are discussed below. References are made to figures from the comprehensive EBS report completed by Tetra Tech EM, Inc. (TTEMI, 2000). The referenced figures from the comprehensive EBS are included in Appendix A.

- Section 1.0 – Introduction
  - Presents an introduction to the SAP and this FSP, including site history, environmental setting, an overview of site operations and process knowledge, and a summary of the comprehensive EBS.

- Section 2.0 – Project Organization and Responsibilities
  - Identifies organizations, roles, and responsibilities for key personnel to be used during the field activities.

- Section 3.0 – Sampling Program Rationale
  - Presents a sampling strategy based on the data quality objective (DQO) process.

- Section 4.0 – Field Activities
  - This section presents a description of the field activities, the rationale for conducting the activities, the field protocols to be used during the activities, and laboratory analysis for the planned sampling activities.

- Section 5.0 – Sample Chain-of-Custody/Documentation
  - Presents details regarding sample documentation including field logbooks, sample labels, sample collection field sheets and chain-of-custody.

- Section 6.0 – Sample Packing and Shipping
  - Presents details regarding sample packaging, shipping and archiving.

- Section 7.0 – Investigation Derived Waste
  - Presents details regarding handling, storage, and disposal of investigation derived waste.

- Section 8.0 – Daily Chemical Quality Control Reports (DCQCR)
  - Presents details regarding quality control reports.

- Section 9.0 – Corrective Actions
  - Presents a discussion of corrective actions for non-conformances identified in the field.

- Section 10.0 – Project Schedule
  - Presents a schedule for the field activities and reporting associated with this FSP.

- Section 11.0 – References
  - Presents references that are relevant to the basis of this FSP.

1.2 SITE HISTORY

The St. Louis Ordnance Plant (SLOP) was constructed in 1941. SLOP was a 276-acre, small arms ordnance plant that produced 0.30- and 0.50-caliber munitions. In 1944, 21.05 acres in the northeast portion of SLOP were converted from small arms munition production to 105-millimeter (mm) Howitzer shell production and this portion was designated as SLAAP. Additional land was acquired on the north side of SLOP (see **Appendix A, Figure 6-1**). Currently, the SLAAP property contains eight unoccupied buildings that were used to house SLAAP's main operating processes.

After World War II, SLAAP was placed on standby status. It was reactivated from November 1951 to December 1954 and again from November 1966 to December 1969 to support 105-mm Howitzer shell production. The plant was maintained and operated by the Chevrolet Shell Division of General Motors from 1951 until 1958, by the U.S. Defense Corporation from 1958 to 1966, and by the Chevrolet Motor Division of General Motors from 1966 until 1972, when Donovan Construction Company was awarded the maintenance and surveillance contract.

In 1984, buildings at SLAAP were renovated to house filing and administrative operations by more than 500 personnel from the U.S. Army Aviation Systems Command (AVSCOM). From 1986 to 1990, SLAAP was under the command of the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM). In 1989, the Department of the Army determined that SLAAP was no longer required to supports its munitions mission, and most industrial equipment was removed from the plant. In 1990, plant ownership and control were placed under the U.S. Army Aviation and Troop Command (ATCOM). As of 1993, SLAAP maintenance and surveillance activities were being subcontracted by Donovan Construction Company to Plant Facilities and Engineering, Inc. (PFE). Since 1998, SLAAP has been vacant and under the control of AMCOM.

1.3 ENVIRONMENTAL SETTING

This subsection summarizes the topography, regional geology, hydrogeology, endangered species, archeology, and wetlands associated with the SLAAP property.

1.3.1 Topography

SLAAP is located in the southern portion of the Dissected Till Plains Section of the Central Lowland Province. The topography of this area consists of rolling uplands with slopes of 2 to 5 percent, and elevations range up to 550 feet above mean sea level. The elevation range within a 2-mile radius of the SLAAP property varies between 500 and 550 feet above mean sea

level (msl), with the general topography sloping gently to the south (EDR, 1999). As reported in the *Installation Assessment of St. Louis Army Ammunition Plant*, the SLAAP property is bounded on the north by Interstate 70, on the west by Goodfellow Boulevard, on the south by PURO Chemical Division (PURO) (located in a portion of the former SLOP site), and on the east by Riverview Boulevard (USATHMA, 1979).

1.3.2 Regional Geology

The geology of the SLAAP property includes surficial deposits consisting of windblown silts and clays known as loess. The loess was derived from the Missouri River flood plain during the Pleistocene Epoch about 2 million years ago. The loess is overlain by a layer of clay and silty clay alluvium (USAEHA, 1993). Based on soil borings drilled to investigate underground storage tanks (UST) and other borings completed during the comprehensive EBS, the alluvium layer is 20 to 25 feet thick and the loess layer is 40 to 45 feet thick (USAEHA, 1993) (TTEMI, 2000). Loess deposits are present to about 25 feet below ground surface (bgs), and silty clays and clays are present to about 20 feet bgs at the SLAAP property (USATHMA, 1979) (TTEMI, 2000). Except for approximately 3 acres, most of the SLAAP property is covered by asphalt or buildings.

Bedrock in the area consists of flat-lying sedimentary formations made up mostly of limestone and dolomite. A slight, regional northeast dip has been modified by several minor folds or flexures that trend northwest to southeast. A soil test boring drilled in 1971 at the SLAAP property revealed that medium-hard, light gray, medium- to fine-grained limestone is present at 64.9 feet bgs. This formation is St. Genevieve limestone of Mississippian age and is overlain by 42.6 feet of medium-hard, light yellow to gray, sandy clay shale of lower Pennsylvanian age (USATHMA, 1979).

1.3.3 Hydrogeology

Bedrock units in and around St. Louis are capable of yielding varying amounts of groundwater. Well yield depends on site-specific geologic and well characteristics. Most wells in the St. Louis area yield a maximum of 50 gallons per minute from depths down to 800 feet bgs (USATHMA, 1979). These wells are screened in limestones and sandstones ranging in age from Mississippian to Ordovician. Water yields of up to 1,955 gallons per minute (gpm) can be expected from wells drilled in thick alluvial deposits that contain little silt or clay-like material. However, no potable water wells are reported to exist within 3 miles down gradient of SLAAP (USAEHA, 1993).

Regional groundwater flow in the SLAAP area is north-northeast toward the Mississippi River. The runoff in St. Louis County discharges to the Missouri River to the north, the Mississippi River to the east, and the Meramec River to the south. No surface water is present on the SLAAP property. Storm water on the property is collected by catch basins that discharge to the Metropolitan St. Louis Sewer District combined sewer system.

1.3.4 Endangered Species

Except for small grassy areas, the SLAAP property is covered by buildings and asphalt. The closest body of water, the Mississippi River, is located about 3 miles from the property. No endangered or threatened species have been identified on the property. According to the

Missouri Department of Conservation, the transfer, outgrant, or disposal of the SLAAP property will not impact any endangered species or cause sensitive environment concerns in the vicinity of the property (Missouri Department of Conservation, 1993).

1.3.5 Archeology

SLAAP is located across the Mississippi River from the American Bottoms archeological region. In 1985, an archeological overview and management plan was prepared for SLAAP. According to the plan, no known or identifiable potential archeological sites are located on the SLAAP property. Most of the SLAAP property is asphalt-paved or covered by structures: therefore, much of it has been impacted by some type of ground disturbance. It is doubtful that any surficial archeological sites remain on the SLAAP property. However, the existence of subsurface archeological deposits is possible (Woodward-Clyde Consultants, 1985).

A letter from MDNRs Division of State Parks dated June 21, 1994 indicates that none of the SLAAP structures are eligible for inclusion on the National Registry of Historic Places (MDNR, 1994).

1.3.6 Wetlands

A 1994 National Wetlands Inventory map of the area within 2 miles of SLAAP was reviewed to identify surface water bodies and wetlands. According to the map, the closest wetland is approximately 1.4 miles east of SLAAP, and another wetland lies approximately 1.5 miles northwest of SLAAP. No wetlands were identified on the SLAAP property or in its immediate vicinity (EDR, 1999).

1.4 OVERVIEW OF SITE OPERATIONS AND PROCESS KNOWLEDGE

This section presents an overview of the manufacturing activities conducted at the site, as reported in the comprehensive EBS report (TTEMI, 2000). Since construction of the facility in 1941, SLAAP has supported two primary production missions. First, several of the SLAAP buildings were utilized in support of 0.30-caliber munition production as part of SLOP operations from 1941 through 1944. Second, SLAAP was utilized to produce 105-mm Howitzer shells during intermittent operation phases from 1944 through 1969. Accordingly, an overview of each of the production missions is presented in the following subsections with respect to general site layout, summary of the product processes, and building descriptions. **Tables 1-1** through **1-11** provide a summary of the operational information with respect to both production missions for each of the SLAAP buildings.

1.4.1 Manufacturing Processes from 1941 to 1944

General Site Layout

Appendix A, Figure 6-1 shows SLAAP's north property boundary when it was part of SLOP from 1941 through 1944. SLAAP's north boundary ended along the north side of the train tracks that served former Building 202 ABC (now Building 3). In the extreme northwest area, the property boundary extended approximately 280 feet north to accommodate a parking area

measuring approximately 360 by 280 feet. Except for a guard house (Guard House 209 E), no buildings or manufacturing activities appeared to have occurred at areas north of the railroad train tracks that ran north of Building 3. Residential housing units were located to the north of the SLOP property.

The small arms ammunition (0.30-caliber) production unit was comprised of a 0.30-caliber production building (Building 3), a 0.30-caliber loading building (then referred to as Building 202D, now Building 5), a 0.30-caliber primer insert building (then referred to as Building 202E, now Building 6) and a powder canning building (then referred to as Building 202F and later converted to the acetylene production [Building 9], now demolished). Other buildings included the powder storage building (Building 202H, now demolished), oil storage buildings 202 J and 202 K (now demolished but originally located south of Buildings 5 and 6, respectively), Guard Houses 209 and 209 F, and Building 236 D. Guard House 209 was located on the northeast area of the property on Riverview Boulevard. Guard House 209 F was located at the northwest parking area entrance. Building 236 D was a fire equipment house, which is now attached to the SLAAP Compressor Building (Building 4).

Underground tunnels connect Building 6 to Building 3, Building 5 to Building 3, and Building 6 to the former SLOP Building 203, which is now part of the CONTICO Company. These underground tunnels were used to extend high-pressure steam, treated de-ionized water, and other utilities from SLOPs centralized service center to the SLAAP buildings.

Summary of the Production Process

The 0.30-caliber ammunition round consists of a brass cartridge case, a projectile, powder, and a primer. Manufacture of the cartridge case began with a brass cup. The cup was shaped through a series of cold forming operations, including drawing and other shaping processes. The brass was annealed (heated evenly while maintaining the heat level) at various times during the shaping process to eliminate metal stresses caused by the drawing operations. The brass was also pickled (treated with sulfuric acid) to remove metal oxides. Lastly, the brass was washed and dried to remove the sulfuric acid and associated moisture.

Procedures for fabricating the projectile were similar to those used to shape the cartridge case. Each projectile had a copper jacket shaped through a series of drawing and shaping processes similar to those employed during production of the cartridge case. A lead core (produced elsewhere) was inserted into the copper jacket (ball ammunition) in bullet assembly machines. Armor piercing rounds contained hardened steel cores instead of lead cores.

Smokeless powder and primer (both produced elsewhere) were added to complete the round. A primer such as lead styphnate, was added to the base of the cartridge case after the case was pierced and waterproofed with a varnish (shellac). This operation took place at what is now Building 6. A small quantity of smokeless powder was loaded into the cartridge case and the projectile was assembled and crimped. The loading, assembling, and crimping operations were conducted at what is now Building 5.

Appendix A, Figures 6-2 and **6-3** show the areas in Building 3 where specific 0.30-caliber ammunition manufacturing operations took place on the first and second floors, respectively. **Appendix A, Figure 6-4** shows the locations of manufacturing operations within Building 5 and

6. Each of these process areas, as well as those support processes conducted in Buildings 202 F, J, and K, are discussed in detail below.

Building 3, First Floor

For ease of reference, text discussing the layout of Building 3 will cite locations of alphanumeric building I-beams and columns as originally designated in record drawings as shown in **Appendix A, Figures 6-2** through **6-4**. This grid system designates the furthest north I-beam row as Row A. The I-beam number 1 is designated as the furthest west I-beam Row. Thus, I-beam B2 is the second I-beam from the north end of the building, and the second I-beam from the building's west wall.

Materials were received at the loading dock between I-beam Rows A and B and Rows 1 through Row 11, where a 3-ton hoist unloaded case cups, ball jackets, armor-piercing jacket coil stock and other raw materials. Raw materials were stored either in the southwest corner of the building between I-beam Rows H and L, and 2 and 5, or at the coil stock storage area between I-beam Rows 4 and 10, and C and G.

Coil reels were fed to either seven jacket blank and cup machines or to four base blank and cup machines located in the aisles between I-beam Rows 9 and 11, and C and H. Nine first-draw machines and 11 second-draw machines were installed in the aisles between I-beam Rows 11 and 13, and B and H. Twenty-eight bump machines were aligned in pairs between I-beam Rows 13 and 14, and B to H. A soap mixing room with two mixing systems was located in a room at I-beam Row 13 between I-beams A and B. The soap was used in pickling operations on the second floor. Fourteen third-draw machines and 10 first-trim machines were located along the aisle between I-beam Rows 14 and 15 from Rows B through H. Nineteen first-draw machines were located east of I-beam Row 15 between Rows B and H. Eighteen fourth-draw machines were located next to I-beam Row 16, nine on the east and nine on the west side of I-beam Row 16 between Rows B and H. Twenty-nine second-trim machines, nineteen on the west and ten on the east were located along I-beam Row 17 between I-beams B and H. Thirty pocketing machines were located along I-beam Row 18 between Rows B and H. The aisle between Rows 19 and 20 was occupied by 30 heading machines arranged in a similar fashion as the pocketing machines between I-beam Rows B and H.

A second loading dock was located between I-beam Rows 15 and 17 west of the electrical transformer vault between I-beam Rows A and B. Scrap salvage, including a baler system, was located in a room confined between I-beam Rows A and B and Rows 17 and 21.

Open corridors or aisles were maintained between I-beam Rows B and C and between I-beam Rows G and H throughout the first floor of Building 202 ABC. A maintenance area and a tool and machine shop were located west of the storage area between I-beam Rows 5 and 9 from I-beam Rows H to L.

Six Salem annealing furnaces, each equipped with independent turbo compressors, product elevators and quench tanks, were located between I-beam Rows 10 to 17 on the south side of the building. The product to be annealed was fed from the second floor through rectangular hoppers located on the north side of the furnace that connected directly to the annealing furnace drive system. The product was then quenched and transferred to the second floor by elevators located south of the furnaces.

South of I-beam Row K, between I-beam Rows 17 and 20, were 27 jacket trim machines, 23 for ball jackets and four for armor-piercing jackets. Twelve jacket first-draw machines, nine dedicated for ball jackets and three for armor-piercing jackets were located south of I-beam Row H between I-beam Rows 17 and 20. Twelve jacket second-draw machines were located north and south of I-beam Row J between Rows 17 and 20. Eighteen jacket third-draw and three jacket fourth-draw machines were located in the aisle between I-beam Rows J and K and Rows 17 through 20.

An air compressor room was located between I-beam Row 24 and 25 and A and B. Loading docks were located in the open bay between I-beam Rows A and B from Rows 26 to 32, and from I-beam Row 34 to the east end of the building.

Cup manufacture began in the bay between Rows 21 and 23 and C through G. Up to 47 head-turning machines (16 west of I-beam Row 22 and 31 in the aisle between I-beam Rows 22 and 23) were mounted on benches. Spiral chutes and elevators on the north and south ends transferred product between the first and second floors . Three vibrating feeders, fifteen body annealing furnaces, and an elevator were located just east of I-beam Row 23 from I-beam Rows C through G.

Twenty-nine taper and plug machines were located east and west of I-beam Row 24. These machines received product from two spiral chutes located next to I-beam C24 via feeders and belt conveyors. Product from the taper and plug machines was transferred to a belt conveyor located at floor level that discharged to the product elevator located near I-beam G24.

Twenty five finishing and trimming machines were located along I-beam Row 25. A spiral chute fed product from the second floor to a vibrating feeder. The vibrating feeder discharged to a feed belt conveyor that supplied the finishing and trimming machines. The product was then transferred to an elevator located on the north end just northwest of I-beam C25.

Mouth and neck annealing took place between I-beam Rows 25 to 27 and C through G. The aisle between I-beam Rows 25 and 26 and C through G housed one annealing laboratory. Twenty-four mouth and neck annealing machines were located in the bay between Rows 26 and 27. Casings were transferred from the second floor by a spiral chute and vibrating and rotary feeders to the mouth and neck annealing machines from the south end. The annealing machines discharged the casings to an elevator, rotary feeder and feed belt to the 30 final inspection machines located along I-beam Row 27. The casings were then transferred to the piercing machines by an elevator located at the south end of the final inspection machines southeast of I-beam G27.

Fifty bullet assembly machines, approximately thirty-six for ball bullets and fourteen for armor-piercing bullets, were located in the area between I-beam Rows 22 and 28 south of Row H to the south wall, leaving aisle space near the south building wall. The finished cartridge storage area was located between I-beam Rows B through G through the east end of the buildings. An inspection area was located east of the bullet assembly area between I-beam Rows 28 to 33 south of Row H. A cafeteria with a kitchen and a men's locker room were located at the southeast corner.

Building 3, Second Floor

The west end housed a canteen area with a kitchen, storage room, fan room, and women's and men's locker rooms. The canteen was located between I-beam Rows B and G, and 1 and 8. The locker rooms were located south of I-beam Row G from Rows 1 through 9.

The same manufacturing operations described for the first floor were supported or performed on the second floor. Hoppers transferred cartridge case product from the second floor to the first floor and elevators conveyed product from the first floor to the second floor. The hoppers and elevator were located at the blank and cup, first-draw, second-draw, bump, third-draw, first-trim, fourth-draw, second-trim, and pocketing and heading machine lines from I-beam Rows 10 to 20, between I-beam Rows C and G. Similarly, the bullet jacket draw area included floor hoppers that conveyed bullet jackets to the first-draw, second-draw, third-draw and fourth-draw and jacket-trim areas. This area was located south of I-beam Row H between I-beam Rows 17 and 20.

Six 2,000-pound Salem picklers were located south of I-beam Row H between I-beam Rows 10 and 17. Each pickler was equipped with an independent pickling tank with vent system, acid rinse, cold-water rinse, hot-soap bath, hot-water rinse and dryer. Each pickler was placed within a drainage area with independent floor drains connected to the building sewer system. Six floor hoppers fed the Salem furnaces on the first floor. The hoppers were located north of I-beam Row J between I-beam Rows 10 and 17. Two product washers served by a common floor drain were located south of I-beams H10 and H11. Two more washers, each with a dedicated floor drain, were located along the north building wall south of I-beams B14 and B17. Two wash-and-dry machines were located in the cartridge draw area, each with independent floor drains. One machine was located between I-beams C13 and C14, and the other was located south of I-beams B18 and B19. Aisle space was maintained in the second floor of Building 202 ABC between I-beam Rows 20 and 21, at the north side of I-beam Row H, and along the south building wall.

Seven product washing machines and two drying machines were located between I-beam Rows 20 and 22. Two soap mixing machines and five wash barrels were also located in this area between I-beam Rows C and E. Four head-gauge shaker tables were located between the head turning and body annealing lines. A roller conveyor on the floor was used to transfer baskets used to feed the Lindberg furnaces located south of I-beams C25 and C26. Pickling and rinsing units, six wash barrels and two dryers were located in the bay between I-beam Rows 25 and 26 from Row D to just south of Row G.

Two fuel gas mixing systems were located in a room south of the north building wall between I-beam Rows 24 and 25. A washer was south of I-beams G24 and G25.

The hoppers that fed the 50 bullet assembly machines were located between I-beam 22 and 28, south of I-beam Row H though the south wall, leaving aisle space near the south building wall.

After final inspection, the cartridge cases were transferred to the Primer Insert Building (Building 6) by an overhead conveyor belt.

A 5-day cartridge storage area was located between I-beam Rows 29 and 34, and B and F. Four cartridge clip assembly units were housed between I-beam Rows 34 and 35, and between the north building wall and I-beam Row E. Forty-eight gauge and weight stations were located between I-beam Rows 28 to 37, and F and H. Five labeling and packing machines with a gravity roller conveyor and spiral chute to the first floor storage area were located between I-beam Rows

36 and 39 in the northeast corner of the building. Five Inman partition machines were located next to the east building wall between I-beam Rows F and H.

A loaded scrap salvage area was located between I-beam Rows 29 and 31 north of the south building wall. Primed cartridges inspection benches were located north of the south building wall between I-beam Rows 32 and 34. The inspection layout room was located along the south building wall between I-beam Rows 34 and 36. The southeast corner of the second floor was utilized as a women's restroom and locker room.

One overhead bridge connects Building 3 to Building 6 via the bridge between I-beam Rows 27 and 28. This bridge conveyed cartridge cases from the final inspection line for primer insertion.

Building 5

Appendix A, Figure 6-4 shows the former manufacturing areas from the first floors of Buildings 5 and 6. Five 0.30-caliber powder loading, assembly and crimping stations (four on the south side and one on the northeast side) were located in Building 5. This building did not have automatic loading machines. Four case shakers, one at each of the south stations, were used to supply cases for powder loading. Roller conveyors transferred cases from the case shakers to the powder loading compartment.

Four jacket shakers, one at each of the south stations, were used to supply ball or armor-piercing jackets for bullet assembly. A second conveyor system transferred loaded cases to just outside the independent assembly compartment, where the jacketed bullet was attached to the loaded cartridge case. The assembled bullet was crimped at one of the four independent crimping compartments. The cartridges were then identified in one of the four identifying units, inspected, and conveyed to the second floor of Building 3 for further processing.

It appears as if a station at the northeast corner of the building was a non-operational spare station. This station contained only powder loading, assembly, and crimping compartments and machines. No ancillary conveyor systems, tables, inspection benches, case and jacket shakers or identifying units were present. Other equipment on the second floor included the elevator and the conveyor system that brought the product from the first floor of Building 5 to the second floor of Building 3 to the gauge and weight area. No other equipment was installed on the second floor of Building 5.

Building 6

Appendix A, Figure 6-4 shows manufacturing areas in the first floor of Building 6 where ten primer invert machines and 36 primer insert machines were located. A laboratory equipped with service and primer drop test benches was located in the southeast corner of the building. Four of the primer invert machines were located in the middle section of the building, two along the south building wall and two along the north wall. The other six primer invert machines were located in the extreme southwest corner of the building, south of the locker rooms.

Thirty-six primer insert machines were located along the middle section of the building. Cartridge cases were fed from the overhead conveyor belt, into a spiral chute located on the second floor, and into a vibrating feeder located on the east side of the building. A feed belt that ran along the middle section of the building received the cartridge cases and transported them to the primer insert machines, which were arranged in pairs, one on each side of the feed belt.

Rectangular chutes transferred the cases to the primer insert machines. The primed cases were discharged to a belt conveyor that ran at floor level, and in turn, supplied an elevator located east of the spiral chute. Other than the conveyor system on the second floor, no equipment was installed on the second floor of Building 6.

Buildings 9 and 9A

Powder canning and storage took place at Buildings 9 and 9A, respectively. Powder containers (15-inch-diameter cylinders approximately 2.5 feet tall and weighing 185 pounds) were emptied into rectangular brass hoppers that were located within an enclosed wall system designed to contain accidental explosions. The hoppers delivered smokeless powder to the canning table via copper tubing through a concrete wall. The copper tubing was fitted with two quick-action valves, one before and one after the concrete wall.

Buildings 202 J and 202 K

These buildings were used for oil storage to support the operations at Buildings 5 and 6. The buildings were 6 feet wide, 13 feet long, and 8.5 feet high, and were constructed on a 12-inch-thick concrete slab without drains. A maximum of four oil drums could be stored and used at each of these buildings.

1.4.2 Manufacturing Processes After 1944

General Site Layout

Appendix A, Figure 6-1 depicts the site layout of the SLAAP facility for the post-1944 operational periods. A total of eleven buildings were utilized in primary production and support roles. Five of these buildings were retrofitted from .30 caliber manufacturing operations to accommodate 105-mm Howitzer shell production (Buildings 3, 5, 6, and 9). The remaining buildings (Buildings 1, 2, 4, 7, 8, 10 and 11) were constructed in 1944.

Primary manufacturing operations were conducted in Buildings 1 through 3. Building 1 housed billet cutting operations, Building 2 served as the forging center, and Building 3 contained the machining operations. Support functions to manufacturing operations were provided by Buildings 4 through 11. Building 4 contained air compressors, Buildings 5 and 6 provided office and laboratory space, Buildings 7 and 7A cooled noncontact waters used during manufacturing, Buildings 8 (fuel oil tank farm) and 8A (fuel oil tank pump room) delivered fuel to the rotary furnaces in Building 2, Buildings 9 and 9A through 9D generated acetylene and housed an oxygen converter and receiver all in support of Building 1 operations. Building 10 stored and supplied quench oil to Building 3 heat treating operation, and Buildings 11, 11A, and 11B generated foamite to support fire suppression efforts. **Appendix A, Figures 6-5** through **6-13** show the locations of major equipment areas in each of the buildings.

Following conversion to 105-mm Howitzer shell production in 1944, a total of 2,500,000 shells were produced for World War II until the plant was placed on standby in September, 1945. Operations were reactivated on March 25, 1951 by the Chevrolet Motor Division to support the Korean Conflict. From 1951 to 1954, the plant produced 19,094,325 shells. Plant operations were terminated on May 1, 1954 and SLAAP was placed on interim maintenance status. In

1966, the Chevrolet Motor Division reactivated the plant to support the Vietnam War. Production began in November, 1966 and continued through December, 1969. The production rate reached 600,000 shells per month shortly before operations were terminated. In total, the plant had produced a total of 23,878,646 shells in all three runs (USATHAMA, 1979).

Wastewater discharges from SLAAP were monitored periodically by the Metropolitan St. Louis Sewer District, and discharges were in compliance with applicable city ordinances. Solid wastes and some liquid wastes were removed from SLAAP for off-site disposal and recycling by a local contractor (USATHAMA, 1979).

Building 1, Billet Cutting Building

Steel billets were stored in concrete and H-beam racks outside of the eastern and western steel yards next to Building 1 (see **Appendix A, Figure 6-5**). Long, 4-inch square steel billets or bars were fed into the building via conveyor systems to four nicking machines (two on the east and two on the west sides). Each nicking machine consisted of eight oxygen-assisted acetylene torches that would create a nick approximately 1/4" deep and 3/16" wide along the width of each bar. Following nicking, conveyor feeds would move the billets through a direct-contact water cooling process to eight breaking machines (each rated for 530 slugs per hour). The breaking machines were situated inside concrete pits that drained to the south of the building into the sewer system. Billet ends from each end slug were cut to size in cold saw machines. Snag grinding, as necessary, was completed on all breaks that did not meet specifications. Dust collectors with vent hoods were located directly above the nicking machines and directed fumes and fine metallic particulates into dust collectors located inside the building. Ventilators were located next to the saw and grinding machines. Liquid wastes were pumped to the facility sewer system (USATHAMA 1979). Following inspection, the finished 8-1/2" slugs were mounted on skids and transported to the forge building (Building 2).

Building 2, Forge Building

Building 2 (**Appendix A, Figure 6-6**) served as the forge building. Building 2 housed a total of 10 rotary furnaces, 5 were combination natural gas- and oil-fired rotary furnaces and 5 were oil-fired furnaces for slug heating and forging. The inside of the building was almost symmetrically configured, with five rotary furnaces on each side of the building. The cut billets were received from Building 1 and fed into the rotary furnaces. Each furnace was equipped with a rectangular skid conveyor that transferred the hot billet to the sizing and descaling units. The billets were then transported to the piercing presses, where a cup was first formed through hydraulic force. Two piercing presses served each rotary furnace. Following piercing, the billets were then transferred to the hydraulic presses and draw benches, where they were drawn through a series of progressively smaller ring dies. After drawing, the formed billet was inspected and cut to length at the hot cut-off machine. One cut-off machine was present at each rotary furnace unit. The shells were then transferred by the air cooling conveyor to the water quench tanks. A descaling tank was located in the middle western half of the building. After cooling, the shells were mechanically conveyed to the second floor of Building 3 by an elevated covered bridge that connects these two buildings.

Hydraulic accumulators (one on each side of Building 2) were utilized to supply hydraulic oil to the forging process. Each hydraulic accumulator consisted of 10 hydraulic pumps connected to

an above ground, 5,000 gallon oil tank in the middle section of the building. Natural gas was supplied by an underground utility supply system. No. 6 fuel oil was supplied by Buildings 8 and 8A through underground fuel lines. Each furnace had a dedicated oil fuel line that came through the floor near an I-beam next to the furnace.

Electrical transformers and equipment were housed in two enclosed elevated mezzanines located in the bays between the walls and the first I-beam row inside the building.

Building 3, Machining Building

The first and second floors in Building 3 were used for machining operations. **Figures 1-7** through **1-10** [EBS Figures 6-7 through 6-10] show areas in Building 3 where major equipment was located in the basement, first floor, second floor, and roof, respectively. The building housed various lathe operations; hydraulic presses; conveyors; air-driven machinery for steel cutting, shaping, and finishing; and metal preservative operations. Other equipment included welding machines; machine, electrical, and carpenter shops; and a small automotive shop. A self-contained liquid storage area was located on the first floor that stored various oils, solvents, and chemicals. As of January 1969, the following oils, greases, and process fluids were used:

- MR 186 - hot forging compound
- Molyshield grease - Alubo
- MX-2 Hi-Temperature grease
- Coolex # 25 coolant
- GM-3 Cold hosing compound
- Spindle oil
- Various lubricating oils (Regal, Mobil, and Shell)
- Hydraulic oil General Motors Specification 16A
- Ecnogrind
- Hot Forging Compound

Process fluids included (USATHAMA, 1979):

- Thinner (toluol used at a rate of 45,000 liters per month)
- Enamel 1T-E-516 (used at a rate of 159,000 liters per month)
- Primer MIL-P-223332A (used at a rate of 36,000 liters per month)
- Corrosion-preventive phosphoric acid (used at a rate of 2,500 liters per month)

The following discussion of Building 3 processes is organized to follow the flow of production.

Appendix A, Figure 6-9 shows equipment areas on the second floor of Building 3. Fourteen furnaces were located between I-beam rows 28A through 43. Rough machining equipment was also located on the second floor of Building 3. Forged shells were put through the bore nose or Sundstrand lathe (between I-beam Rows 11A and 14) followed by shot blasting (between I-beam

Rows 14 and 17). The shells would progress through the machining process from west to east, ending at the annealing furnaces at the east end of the building. Center lathes were located between I-beam rows 18 and 20, and the rough-turning gross lathe was located between I-beam Rows 21 through 25.

Appendix A, Figure 6-8 shows the location of major equipment on the first floor of Building 3. A paint stripping room was located on the east end of the building north of the garage. Quench oil tanks used to quench the shells after heat treatment in the annealing furnaces were located west of the paint stripping room. Shell washing was conducted before painting, which was conducted in paint booths west of the quench oil tanks. Shell washing included the addition of phosphoric acid, rinsing, chromic acid bath prior to painting The paint mixing room was located between I-beam Rows 28A and 32. The area outside the paint mixing room stored empty barrels. Four paint mixing stations were used inside the paint mixing room. Various lathing, welding, and grinding areas are located between I-beam Rows 6 through 24. Grinders, shapers, mills, and lathes are also located between I-beam Rows 6 through 9. A hydraulic oil reclaiming unit was located on the north side of the first floor of Building 3, between I-beam Rows 10 and 11A, and 11 B. A soluble oil mixing room was located next to I-beam Row 13 between Columns A and B.

The basement (**Appendix A, Figure 6-7**) contained four transformer vaults, a cable vault, elevator pits, two quench oil transfer pump systems, two former quench oil tanks, a former sludge pit, and a former gasoline UST. The quench oil pumps supplied make-up oil from each of the quench oil tanks. A return line located between I-beams Columns E and F collected quench oil from the first floor and conveyed it to the quench oil sludge pit to remove particulates and sediment. This tank overflowed into the quench oil tank next to the quench oil sludge pit. The three quench oil tanks were hydraulically connected. The overflow from the oil sludge pit was directed by gravity to the oil tank south of the pit. The concrete floor area was located between I-beam Rows 9 and 23.

The roof of Building 3 contained cooling towers, paint room exhaust fans, furnace exhaust fans, and dust collectors for machining operations performed on the second floor (**Appendix A, Figure 6-10**). The cooling towers served the furnaces and cooled quench oil, hydraulic oil, and other fluids through cooling water from Building 7.

Building 4, Air Compressor Building

Building 4 was the air compressor building. Five compressors were connected to ten air intake lines, two for each compressor. The intake lines were located outside along the south wall of Building 4. **Appendix A, Figure 6-11** and **6-12** show major equipment in the basement and ground level of Building 4. Individual air filter systems were connected to each air intake outside the building. The intakes entered the building beneath the floor into the compressors. Each compressor was equipped with an intercooler and aftercooler (located in a pit below the floor level). Five air receivers were aligned outside the north wall of Building 4. A cable room and vault are located in the western portion of the basement of Building 4.

An electrical room that housed the motor control center for the air compressors and other equipment was located west of the compressors area.

Buildings 5 and 6, Headquarters and Office Building and West Office and Laboratory Building

Appendix A, Figure 6-13 presents the equipment layout for Buildings 5 and 6 during the 105-mm Howitzer production. Building 5 was primarily used for office space. It consisted of a two-story building with an elevator and restrooms. No 105-mm Howitzer shell production took place at this building.

Building 6 was also used as office space and housed an inspection department and laboratory. The laboratory consisted of a chemical department, physical department, office, dark room, and chemical storage area. A deep-etch fume hood was located along the south wall. Lockers and restrooms were located in the west end of the building.

Buildings 7 and 7A, Water Pumphouse and Cooling Tower

Appendix A, Figures 6-11 and **6-12** show major equipment at Buildings 7 and 7A. Five centrifugal pumps were used in Building 7 to support water and other cooling fluid requirements.

Buildings 8 and 8A, Fuel Storage Area and Oil Pumphouse

Former Buildings 8 and 8A are depicted in **Appendix A, Figure 6-6**. Nine No. 6 fuel oil tanks were located first north of Building 2 and then relocated in 1958 to the east side of Building 2.

Buildings 9 and 9A through 9D, Acetylene Generation Area

The acetylene generation area consisted of the Acetylene Generator Building (Building 9), the Carbide Storage Building (Building 9A), the Sludge Pits (Building 9B), the Oxygen Receiver (Building 9C), and the Driox Oxygen Converter (Building 9D). The Oxygen Receiver (Building 9C) was an AST owned by the oxygen gas supplier. **Appendix A, Figure 6-1** depicts the areas where these buildings were located.

Building 10, Quench Oil Storage Tanks

Building 10 was a series of tanks installed to increase production of 105-mm Howitzer shells. **Appendix A, Figure 6-1** depicts these tanks. The three quench oil tanks and the quench oil sludge pit were located outdoors in front of the east end of Building 3 and supplied cooling oil (No. 6 fuel oil) to 14 quench oil tanks located on the first floor of the east section of Building 3.

Buildings, 11, 11A, and 11B, Foamite Generator Building and Hose Cart Shelters

Building 11 housed the foamite generator system. **Appendix A, Figure 6-6** shows the location of the existing and former Buildings 11, 11A, and 11B. The original system included a 15-horsepower pump system, a foamite generator, and a 4-inch-diameter foamite line that left the south corner of Building 11 and split into two main lines. Foamite was used to extinguishing fires and was made by mechanical agitation of a protein-based (normally hydrolysate) surfactant water and minor amounts of ferric hydroxide (used as foam stabilizer).

1.5 SUMMARY OF ENVIRONMENTAL BASELINE SURVEY

The comprehensive EBS [TTEMI, 2000] was completed in general accordance with American Society for Testing and Materials (ASTM) Method D 6008-96, "Standard of Practice for Environmental Baseline Surveys," and ASTM Method E 1527-97, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process."

A record search and initial site visit was conducted as part of the comprehensive EBS to identify possible areas of environmental concern at SLAAP. The record search indicated that a Notice-of-Noncompliance (NON) was issued by U.S. Environmental Protection Agency (EPA) Region VII to SLAAP for polychlorinated biphenyl (PCB) contamination in Building 3. To date, this NON has not been resolved. AMCOM has reviewed this NON with EPA Region VII and the U.S. Army Corps of Engineers (COE) is remediating the PCB contamination in Building 3. Records also indicate that underground storage tank (UST) removals at SLAAP have not been completed in accordance with MDNR requirements. Possible sitewide areas of environmental concern consist of contamination resulting from possible contaminant migration from the PURO Chemical storage facility (formerly part of SLOP) located south of the installation, as well as friable asbestos-containing materials (ACM), lead-based paint (LBP) and PCBs contained in original fluorescent light ballasts found at SLAAP.

The following building-specific possible areas of environmental concern were identified through the records reviewed and the initial site visit of the comprehensive EBS:

- Electrical equipment in Buildings 1, 2, and 4 have oils suspected of containing PCBs.
- Spilled oil was identified in Buildings 1, 2, 3, and 5.
- Concrete-filled hydraulic oil pits, sumps, and floor drains were identified in Building 1.
- Two pits connected to the sewer system were observed at Building 1.
- Debris was present throughout Buildings 1, 2, and 4.
- Building 2 contained subgrade pipes for distributing hydraulic oil with PCB's.
- Soil near the chip chute in the basement of Building 3 is suspected of containing PCBs and pesticides.
- Oil staining was present along the far east foundation wall, on the floor, and on support columns in the vicinity of the quench oil pump room in the basement of Building 3.
- Suspect ACM and suspect PCB-contaminated metal shavings were observed on the basement floor of Building 3.
- A steel separator tank was identified in the south-central portion of the basement of Building 3. The tank was filled with a dried, oxidized material. This material may be of environmental concern. Other pieces of equipment were located in the basement.
- Cracks in the PCB remediated concrete cap were observed on the first floor of Building 3.
- Paint used to seal the steel structures on the first floor of Building 3 was cracking and peeling.
- A solvent room with a drain connected to the sewer system was identified in Building 3 plans.

- A room on the second floor of Building 3 contained an emergency power supply unit. This unit may contain lead-acid or nickel-cadmium batteries.
- A remote quench oil-fill pipe was located near the northeast corner of Building 3.
- The compressor pits in Building 4 are suspected of containing compressor oils with PCB's.
- Ash was observed in a hearth in Building 6.
- The aboveground storage tanks formerly present at Building 8, east of Building 2, are suspected of having leaked and spilled fuel oil.
- USTs have not been officially closed, and may present a possible environmental concern.

Phase I EBS results were presented to the MDNR on April 23, 1999 and EPA Region VII. The Phase I results were used to develop a scope of work that included completion and sampling of soil borings, installation and sampling of monitoring wells, wipe sampling, surface soil sampling, concrete core sampling, and an ACM survey. The scope of work for investigating the aforementioned possible areas of environmental concern was coordinated between TTEMI and AMCOM and verbally endorsed by EPA Region VII and MDNR.

Phase II EBS activities were completed in two separate sampling events. The first Phase II sampling event identified areas of contamination and the second Phase II sampling event was performed to further assess and characterize these areas. During a meeting held at the EPA Region VII offices in Kansas City, Kansas, on September 9, 1999, the results from the first Phase II sampling event were reviewed to assess additional areas to investigate, address PCB sampling to resolve the outstanding PBC NON, and additional locations to sample to address the unresolved, outstanding UST cleanup. The first Phase II results were reviewed sitewide and building-by-building. The scope of work for the second phase of the EBS Phase II was developed and work was undertaken based on the outcome of the September 9, 1999 meeting. The data collected during Phases I and II were used to compile the results of the EBS. The draft final EBS report was submitted for review on March 17, 2000 and a meeting to review the report took place on March 31, 2000 at the EPA Region VII offices. During that meeting, the draft final EBS report was briefly reviewed. It was agreed that additional information was required, primarily related to:

1. manufacturing activities that took place at SLAAP when it was part of SLOP
2. the EBS analytical data validation report performed by IT Corporation was necessary to assess the validity of the analytical results obtained during the EBS
3. the cleanup criteria used for comparison of analytical results should not be limited to the State of Missouri voluntary cleanup program (CALM), but should be expanded to incorporate other cleanup criteria, including the EPA Region IX preliminary cleanup goals criteria

The revised final EBS report, dated December 28, 2000 incorporated the additional information requested at the May 31, 2000 meeting. The EBS conclusions and recommendations are presented in the EBS report dated December 28, 2000 and are summarized **Table 1-12**.

EPA Region VII and MDNR provided comments to AMCOM on the revised final EBS report. TTEMI prepared preliminary draft responses to both EPA Region VII and MDNR comments, which were reviewed during a May 17, 2001 meeting held in St. Louis, Missouri. Attendees to

this meeting included representatives from AMCOM and its contractor SEMCOR, EPA Region VII, MDNR, CENWK, URS, Arrowhead Contractors, Inc. and TTEMI. After this meeting AMCOM undertook the task of documenting the outcome of the review comments and addressing the comments that were not proposed to be deferred to this site-specific EBS. The minutes of the meeting (SEMCOR, 2001) indicated the following remaining areas of concern for the site specific EBS.

Site-wide:

- Areas where EBS mentions areas of environmental concern
- Comprehensive look at sewer system
- UST areas
- Transformer areas
- Metals storage areas
- Sumps

Building 1:

- Sumps
- Soils around break machines – inside
- Subsurface under building – PCB, TPH, solvents

Building 2:

- Subsurface under building – TPH, SVOCs, PCBs, solvents (sample in grid pattern)
- Sediment in manhole - solvents

Former building 8:

- Pipe chase connecting to Building 2

Building 3:

- Catch basins – basement of Building 3
- Soils in basement of Building 3
- Under floor of east end of Building 3
- Area with high gasoline hit – near UST next to Building 3
- West end of Building 3 for solvents in water
- Elevator

Building 4:

- Sumps, compressors

Buildings 5 and 6:

- Lab
- Dark room
- Elevator
- South of buildings – small storage areas

Key personnel for associated activities are summarized below:

KEY PERSONNEL	ORGANIZATION	ROLE	RESPONSIBILITY
Sandy Olinger	AMCOM	Project Manager	• Contract management
Bradley Eaton	CENWK	Project Manager	• Client representative for the project
Kurt Baer	CENWK	Technical Manager	• Management of the SLAAP project • Technical oversight
Debby Snodgrass	CENWK	Risk Assessor	• Technical oversight of the risk assessment process
Masud Zaman	CENWK	Geologist	• Technical oversight of geology
Francis Zigmund	CENWK	Chemist	• QC oversight of chemistry
Laura Percifield	CEWES	QA Laboratory Supervisor	• QA sample analysis
Wayne Smith, P.E.	URS	Program Manager	• Program Manager for Contract DACW41-96-D-8014
Richard Johannes, P.E.	URS	Principal-In-Charge	• Task Order Principal-In-Charge
Robert Skach, P.E.	URS	Project Manager	• Contractor representative for the program • Primary point-of-contact with CENWK and AMCOM • Overall responsibility for all phases of work • Personnel, scheduling, and budget control
John Moylan	URS	Task Order Quality Control Officer	• Technical Oversight
Phil Jones	URS	Certified Industrial Hygienist	• Overall responsibility of URS Health and Safety Program
David Convy	URS	Independent Technical Reviewer	• Peer Reviewer for the SAP and Site-Specific EBS reports
Peter Tong	URS	Independent Technical Reviewer	• Peer Reviewer for the Baseline Risk Assessment
To Be Determined	URS	Site Safety and Health Officer	• Oversight of Site Health and Safety • Designates deputy Site Safety & Health Officer for field work
To Be Determined	URS	Chemical Quality Control (CQC) Representative	• CQC responsibilities as defined in this FSP • Prepare technical reports • Manage and coordinate field work • Primary point-of-contact for subcontract laboratories and QA laboratory
Dana Monroe	URS	Chemist	• Directing overall chemical QA/QC program • Preparation of the QAPP and Quality Control Summary Reports • Technical communications with laboratory • Primary point-of-contact for subcontract laboratories and QA laboratory

KEY PERSONNEL	ORGANIZATION	ROLE	RESPONSIBILITY
Matt Phoenix	URS	Environmental Engineer	• Provide technical input for work plan development • Download of laboratory electronic data files into database • Generation of data tables and graphs for reports
Jim Garrison	URS	Human Health Risk Assessor	• Task Manager for Human Health Risk Assessment
Carla Dods	URS	Regional Health and Safety Officer	• Review Health and Safety Plans • Ensure compliance with URS Health and Safety standards
Charlotte McLain	URS	Procurement Specialist	• Procurement of supplies and equipment
John Borell	URS	Contract Administrator	• Preparation of payment vouchers
Carolyn Horst	URS	Contract Specialist	• Preparation and tracking of subcontracts
Greg Wallace	Arrowhead	Project Geologist	• Coordination with other SLAAP projects • Technical input regarding site geology • Liaison with URS and CENWK
Bryant Kroutch	Arrowhead	FSP Task Leader	• Provide technical input for preparation of FSP and field activities

The site characterization sampling strategy described in this FSP is based on the Data Quality Objective (DQO) process presented in *EPA Soil Screening Guidance: Technical Background Document* (EPA, May 1996). Based on this guidance, a sampling strategy has been developed and organized consistent with the steps of the DQO process:

- State the problem
- Identify the decision
- Identify inputs to the decision
- Define the study boundaries
- Develop a decision rule
- Specify limits on decision errors
- Optimize the design for obtaining data

Each of these steps is discussed below.

3.1 DATA QUALITY OBJECTIVES PROCESS

3.1.1 State the Problem

Collect sufficient data to support transfer of the property consistent with the Finding of Suitability to Transfer (FOST) process.

3.1.2 Identify the Decision

The FOST process determines that a real property is environmentally suitable for transfer because:

- The property has never been contaminated (no release or disposal of hazardous substances or petroleum products has occurred); or
- The property has been contaminated but is still suitable for transfer because
  - environmental remedial actions have been taken to protect human health and the environment consistent with the property's intended use; or
  - the contamination is present at levels that do not represent a threat to human health and the environment, consistent with the intended use.

} SLAAP

Because a FOST commonly incorporates the intended future use of the real estate, the FOST may also include deed restrictions for the property. Such restrictions may be necessary to ensure that unintended uses of the property do not disrupt remediation activities, jeopardize the protection provided by those remedies, or otherwise alter the conditions that allowed an initial finding of environmental suitability.

Accordingly, the data collected in this investigation must support an evaluation of site risk and compliance with environmental regulations. If either of these evaluations suggest remedial actions are required, sufficient data must exist to facilitate the evaluation and selection of remedial alternatives. for dirty or clean transfer

3.1.3 Identify Inputs to the Decision

This step identifies the inputs to the decision process, including the basis for investigation and the applicable field sampling and analytical methods. The inputs for deciding whether to investigate are based on recent site visits and on information contained in the comprehensive EBS Report (TTEMI, 2000).

For sampling of the selected areas of SLAAP, the inputs for deciding whether to investigate are largely based on the findings of the EBS (summarized in **Table 1-12** of this document). **Table 3-1** presents the sampling approach and rationale for each of the environmental areas of concern identified in the comprehensive EBS report.

3.1.4 Define the Study Boundaries

This step in the DQO process defines the sample population of interest (areas and depths of concern), subdivides areas of concern into manageable units, and specifies temporal or practical constraints on the data collection.

Population of Interest

Media of interest include concrete, surface soil, subsurface soil, surface wipes, wastewater, sediment, and groundwater. **Table 3-1** details the rationale on a building-by-building basis for collecting site characterization samples to address each of the areas of environmental concern identified in the comprehensive EBS report. **Table 3-2** provides a summary of sample collection activities for each specific medium.

Areas of Concern

The limits of each area of concern were developed based on the information presented in the comprehensive EBS report with regard to previous environmental investigations conducted at the site and process knowledge of the munition production operations. The locations of each area of concern and proposed sampling locations are shown on **Figures 3-1** through **3-11**.

Constraints on Data Collection

Constraints on the collection of data include physical structures (such as the presence of buildings, railroad tracks, and the site-wide sewer system, etc.), project schedule/timing and funding. Physical constraints will be accommodated by selecting sampling techniques that are most compatible with data needs and access to each area of concern. For example, video surveying of the sewer line or utilization of soil gas surveys to delineate areas for "hot-spot" investigation should minimize physical constraints associated with "blanket-approach" investigations.

Project schedules will be optimized through a phased-approach such that "step-out" investigations are pre-planned and approved in the event that results from phase one investigations suggest additional data are necessary. In this way, most if not all, of the investigations will be completed during one mobilization to the site.

3.1.5 Develop a Decision Rule

Ultimately, the decision rule governing this FSP is a finding that the property is environmentally suited for transfer in accordance with FOST guidelines. For this finding to occur, the intended current and future use of the property must be consistent with protection of human health and the environment. Accordingly, data must be collected of sufficient quantity and quality to support an assessment of risk posed by any contamination such that appropriate remedial measures can be developed and selected.

The sampling program activities that evaluate the nature and extent of contamination within each area of concern identified in the comprehensive EBS report contain both primary and contingency sample locations and collection protocols. The decision of whether or not to implement the contingency investigations will be made by comparing analytical results from the primary samples to regulatory guidelines and statistically determined background contaminant levels.

The regulatory guidelines used will be EPA Region IX Residential Preliminary Remediation Goals (PRG's) and MDNR CALM Scenario A contaminant levels, which are based on residential exposures. The selection of residential exposure limits has been made not because future residential uses are anticipated, but rather to determine the detection limits that allow for maximum flexibility in the decision making process. For compounds where the PRG's and CALM levels are not the same, the more conservative value will be used for making the decision.

For metals and PAHs, background levels for the region will be established by collecting analytical data from at least two regional background sampling locations. Results from the background samples will be used to calculate a value for the regional background contaminant level. The statistically determined background level will then be used in the decision making process. These background samples must be collected at the beginning of the field activities in order to allow for the calculation of background levels to be used during the remainder of the sampling program.

When deciding whether or not to implement a contingency sampling program, the following protocols will be used to make the decision:

- Metals and PAHs – contingency samples will be collected only if the primary sample exceeds the higher of the background level or the PRG or CALM value.
- All other analytes – contingency samples will be collected if the analytical result for a sample is greater than or equal to the PRG or CALM value.

3.1.6 Evaluate Decision Errors and Optimize the Design

Given the typical variability of contaminant concentrations within an area, practical constraints on sample sizes, and sampling or measurement error, the data collected may be inaccurate or non-representative and can lead to incorrect decisions. A decision error occurs when sampling data mislead decision makers into choosing a course of action that is different from, or less desirable than, the course of action that would have been chosen with complete information.

Data obtained from sampling and analysis are never completely representative and accurate. Furthermore, the costs of trying to achieve complete results can often outweigh the benefits.

Consequently, uncertainty in data must be tolerated to some degree. The DQO process controls the degree to which uncertainty in data affects the outcomes of decisions that are based on those data. This step of the DQO process allows the decision makers to set limits on the probabilities of making an incorrect decision.

The DQO process utilizes hypothesis tests to control decision errors. When performing a hypothesis test, a presumed or baseline condition, referred to as the "null hypothesis", is established. This baseline condition is presumed to be true unless the data conclusively demonstrate otherwise, which is called "rejecting the null hypothesis" in favor of an alternative hypothesis.

When the hypothesis test is performed, two possible decision errors may occur:

1. Decide not to remediate an area (i.e., "walk away") when the correct decision (with complete information) would be to "remediate"
2. Decide to remediate when the correct decision would be to "walk away."

The first error would be a "false negative", i.e., failure to detect the presence of contaminants above allowable limits. The second error would result in a "false positive", i.e., concluding that contaminants are present at levels above allowable limits when, in fact, they are not.

False negatives are very unlikely. Laboratory reporting levels will be established commensurate with PRGs for typical residential land use and exposure scenarios (see QAPP, **Table 2**). Given the industrial location and likely future use of the site, the residential PRGs will be well below any resulting calculated remediation threshold, thereby essentially eliminating the possibility of making a false negative decision.

A false positive error could occur if the risk assessment utilized only data obtained from "hot spot" areas. Under this scenario, concentrations utilized in risk calculations would be prejudicially higher than representative conditions (as a result of predetermining sample locations in the vicinity of known contamination). While this approach is required to define the lateral extent of contaminants in each area of concern, conducting investigations in only these areas could bias the environmental data. Consequently, risk assessment data will be collected at systematically determined locations throughout each area of concern.

3.2 RISK ASSESSMENT SAMPLING

Data collected for a risk assessment should be unbiased and of a sufficient scope to permit the evaluation of the risk posed by exposure of receptor populations to all suspect media at the site. The primary media of concern at the site are soils, since removal of any existing structures or intrusive activities at the site will create exposure to soil. Surface soils (0-6 inches bgs) are the most likely source of exposure to future site workers or other populations. Subsurface soils represent a medium of potential exposure to individuals who might perform trenching as part of construction or utility work. Trenching and excavation activities will not likely be any deeper than the deepest utility lines at the site, approximately 10 ft bgs. For these reasons, risk assessment samples must include data from soils at depths ranging from 0-10 ft bgs. There are no exposure pathways for groundwater at the site since contamination is confined to perched zones deeper than 12 ft bgs and there is no current or anticipated future use of this groundwater.

There is no surface water at the site; therefore, no risks are posed by this medium. Contaminants on building surfaces present a potential exposure pathway, but since the best practice for contaminated surfaces is elimination of the exposure pathway (i.e., decontamination or encapsulation), no risk assessment of building surfaces is proposed. Asbestos and lead-based paint are also potential sources of risk, but since building remediation standards are already established for these contaminants, no risk assessment of them is planned. Furthermore, since it is assumed that any future owners of the site will address the remediation of asbestos and lead-based paint, no investigation or remediation activities are currently planned for these media. Air samples will not be collected since the source of risk at the site is contaminants released into the air by the soils, not the air itself. All risk assessment data will be evaluated with respect to carcinogenic and non-carcinogenic affects, and the quantified risk values will be utilized to determine whether or not remediation is necessary for the property to be transferred.

To provide an unbiased source of data for the risk assessment, the data to be used as the sole inputs to the risk assessment will be collected using a systematic approach described in the EPA's *Guidance for Data Useability in Risk Assessment* (USEPA, 1992). Each area of concern has been divided into sampling grids consisting of equally sized grid units using a "best-fit" approach. Soil borings have been systematically placed at the center of each grid unit, as shown on **Figure 3-11**. The railroads and roadways on the site will be characterized by collecting samples from locations placed at uniform intervals along the railroads and roadways. Since rail beds typically have high levels of contaminants unrelated to SLAAP activities (wood preservatives, diesel, etc.), two additional railroad samples will be collected from offsite locations in order to determine whether contaminant levels observed onsite are significantly higher than those observed on offsite railroads.

Samples collected from all risk assessment soil borings will be analyzed for VOCs, SVOCs, PCBs, and metals. Samples from the grids around buildings 3, 4, 5 and 6 will also be analyzed for pesticides since those buildings contain basements in which historical pesticide use is suspected. Buildings 5, 6 and 9 handled explosives during SLOP operations, so samples from Buildings 5 and 6, as well as samples RA-03SB-09 and RA-03SB-18 (see **Figure 3-11**) will be analyzed for explosives. Finally, painting operations in Building 3 have raised concerns about phosphorus and chromium contamination. To address these concerns, the risk assessment samples from Building 3 will also be analyzed for total phosphorus and hexavalent chromium.

In the event that the analytical results from a risk assessment sample dictate the implementation of a contingency sampling program, as defined by the decision rule in Section 3.1.5, additional contingency samples may be required. If the sample with a high contaminant level is surrounded in all directions by other samples from the site characterization or the risk assessment, those surrounding samples will be used to define the extent of contamination and no additional contingency samples will be collected. If there are insufficient surrounding samples to define the extent of contamination, additional contingency samples will be collected. These contingency samples are not intended for use in the risk assessment, but rather are to be used only for characterizing the extent of any contamination discovered during the risk assessment sampling activities.

3.3 SAMPLE COLLECTION SUMMARY

A summary of primary, contingency and risk assessment samples to be collected during the field efforts is provided on a building-by-building basis for each media of concern in **Table 3-2**.

This section presents a description of the field activities and protocols to be implemented during the site characterization and risk assessment sampling efforts at SLAAP. The field activities addressed in this section include:

- Sample Layout and Utility Clearance
- Soil Borings and Sampling
- Wastewater and Sediment Sampling
- Concrete Floor Sampling
- Test Pit and Test Trench Excavation and Sampling
- Wipe Sampling
- Video Surveying of Sanitary Sewers
- Refractory Brick Sampling
- Containerized Decontamination Fluid Sampling
- Equipment Decontamination

Details regarding sampling rationale, sample locations, analytes of interest, etc. are provided in **Table 3-1**. Procedures for field documentation, sample packaging and shipping, handling of investigation derived waste, and field instrument calibration are presented in subsequent sections of this FSP. Protocols associated with laboratory analysis of environmental samples, including container requirements, analytical methods, and collection of QA/QC samples are discussed in the QAPP. Health and safety procedures associated with field sampling activities are specified in the SHERP. Quality control procedures are detailed in the Quality Control Plan (QCP).

4.1 SAMPLE LAYOUT AND UTILITY CLEARANCE

Prior to sampling activities, field personnel will layout the sample locations as indicated on **Figures 3-1** through **3-11**. Sample locations will be established in the field by measuring from nearby existing facilities as presented in this FSP. It should be noted that sample locations shown on Figures 3-1 through 3-10 are approximate and intended to show samples relative to important features of the site. If any sample locations shown on the figures deviate from the important feature they depict (stained concrete, equipment location, etc.), field personnel should place the sample at the feature located in the field. If field personnel observe any obstructions that would render a predetermined sample location inaccessible, the sample location may be moved to the nearest accessible location. Each location will be marked by placing a wooden stake or pin flag or by marking on the floor/pavement surface with spray paint. Sample locations will also be labeled with the corresponding sample ID/number (refer to Section 5.3). Using available as-built drawings and utility maps, sampling personnel will check the initial locations of samples outside the building relative to underground utilities. Additionally, Missouri One Call (1-800-DIG RITE (344-7483)) will be contacted to dispatch utility company representatives for field locating existing utilities (i.e., steam, water, gas, telephone, electric, and sewer). If conflicts with utilities are identified, the sample location(s) will be moved to the nearest safe location. The locations of utilities will be measured in the field from existing site features with a tape and marked on site drawings and field notebooks for future reference.

4.2 SOIL BORINGS AND SAMPLING

Soil borings will be advanced to sample the soil at numerous locations (refer to **Table 3-2**) to investigate possible surface and subsurface contamination and to collect information for risk assessment purposes. Soil borings will be advanced to a depth sufficient to collect samples from the specified depth intervals below the top of native soil or soil fill material. For most borings, the sampled depth intervals will be 0 – 6 inches, 4 –5 feet, and 9 – 10 feet beneath the top of the soil (i.e., under pavement and granular bedding materials). Soil samples associated with sewer lines will be collected at 0 – 6 inches, 4 – 5 feet, and 9 – 10 feet below the granular bedding material near the location where a video survey indicates a suspected leak or breach. If refusal is encountered prior to reaching the required depth, the soil boring will be reattempted at a new location within 3 feet of the initial borehole. If refusal is encountered during the subsequent boring, a sample will be obtained from the one-foot interval immediately above the point of refusal in the second borehole.

Soil borings will be completed by one of two methods. Where accessibility of equipment is not a concern, soil borings will be advanced using a hydraulic push probe (i.e. Geoprobe or equivalent) mounted on a vehicle appropriate for the location (i.e. a rig in open areas, a track mounted device in smaller spaces). Soil samples will be collected from a lined core sampler (i.e. Macro core sampler with acetate liner) pushed or driven by the probe rods. The core sampler will yield a continuous soil core approximately 4 feet in length. In areas that are not accessible to the hydraulic push rig, such as basements or other areas with insufficient clearance, samples will be collected manually using a stainless steel hand auger or small barrel drive sampler (tube sampler).

The majority of the planned soil borings are located beneath concrete flooring or other paved areas. Consequently, it will be necessary to clear the concrete/asphalt prior to sampling. Pavement will be removed either by using a concrete core attachment to the hydraulic push rig or by a using a concrete saw (with diamond cut blade) and pneumatic jack hammer. In areas where samples will be collected with a hand auger or small barrel drive sampler, the gravel base underlying the concrete/asphalt will be cleared to expose the top of the soil. The gravel will be loosened with a power auger and removed using a shovel or post-hole digger.

The general procedure for collecting samples from soil borings will be as follows:

- The soil boring location will be cleared of vegetation or debris. As necessary, concrete, asphalt, and gravel base will be removed using methods referenced above.
- The sampling device (core sampler, hand auger, or small barrel driver) will be advanced to the appropriate depth interval and then retrieved from the borehole.
- Soil from the specified depth interval will be removed from the sampling device and placed into a stainless steel mixing bowl. Prior to placing the sample in the mixing bowl, a sample for VOC analysis, if required, will be collected from the sampling device using a 5-gram or 25-gram Disposable En Core™ Sampler, or equivalent. The sampler will be filled and sealed in accordance with the manufacturer's recommendations.
- After collection of the VOC sample, the remaining soil will be thoroughly mixed with a stainless steel spoon for the purpose of homogenizing the material.

- After mixing, a sufficient quantity of soil will be placed into an appropriate sample container (refer to QAPP, **Table 3**). The container label will be completed by the sampler as described in Section 5.4.1.
- Field QA/QC samples (refer to QAPP, **Table 1**) for VOC analysis, if required, will be collected at the same time and from the same material as the investigative VOC sample. The remaining duplicate and split samples will be collected from the mixing bowl after the soil is homogenized.
- Immediately following collection and labeling, soil samples will be placed into a cooler with ice or a refrigerator and then transported to the field office for packaging, completion of chain-of-custody documentation, and shipment to the designated analytical laboratory(ies) as discussed in Sections 5 and 6.
- The sampling equipment (core sampler, auger, mixing bowl, etc.) will decontaminated between each sample location and between each depth interval as described in Section 4.10.
- For possible future reference (i.e. location/elevation surveying), the sample location will be marked with a wooden stake or spray paint and labeled with the sample ID.

All relevant information for each sample will be recorded on a Sample Collection Field Sheet (refer to **Figure 5-2**), including, but not limited to:

- Date/time of sampling
- Sampling team members present
- Sample location
- Sample number
- Sample depth and interval
- Description of the sample location with sketch, if applicable
- Analyses required
- QA/QC sample IDs
- PID/OVA readings
- Visual classification of soil
- Other visual observations, such as staining or free product

Boring logs (refer to **Figure 5-3**) for each soil boring will be completed. The boring logs will be submitted as appendices to the EBS report. All soil samples will be visually classified in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual - Manual Procedure). The original field logs will be considered a legal document describing the materials penetrated and the specifics of the boring and sampling methods used. The field logs will only be edited to add pertinent information not available at the time of the boring was completed (i.e., survey information). Information on the boring logs will include, but not be limited to, the following:

- Date and start and completion times

- Names of sampling team members
- Weather conditions
- PID/OVM measurements
- Surface elevation (if available)
- Boring log scale will be 1-inch per foot of borehole
- Borehole diameter
- Sample intervals
- Description of the soil sample (include soil classification, staining, odors, or other pertinent information)
- Depth at which significant changes in soil properties occur
- Gradational changes in major lithologic units, including thin lenses and layers and the thickness of each stratum
- Description of material including soil type, consistency or density, color, relative moisture content, secondary features (i.e., worm holes, root castes, fractures, staining, precipitate formation, organic matter, debris), bedding features, and USGS designation
- Identification of any boring problems (i.e., refusal or cave-ins)
- Description of any tools lost or dropped into the borehole
- Total depth of the completed hole
- Type of backfill material (include ratio of materials used).

Extra soil from the sample boring will be returned to the borehole. Following collection of the last sample at a location, the borehole will be backfilled with a dry mixture of 50 percent sand and 50 percent granular bentonite. Paved areas will be backfilled to grade with AB-3 crushed rock or similar material.

4.3 WASTEWATER AND SEDIMENT SAMPLING

Samples of wastewater (if encountered) will be collected from the interior of various sewer manholes. In addition, sediment samples will be collected from the interior of sewer manholes, utility vaults, and process equipment sumps. Field personnel will not be permitted to enter these structures.

Samples of wastewater will be obtained at each manhole location with a decontaminated bottle sampler attached to a PVC pipe or other extended handle. Sediment samples may be collected by one of the following methods, depending on site conditions and field personnel preference:

- Scoop or trowel attached to a PVC pipe or other extended handle
- Hand auger
- Small barrel drive sampler (tube sampler)
- Clam shell sampler.

To the extent possible, sample material will be collected from the entire depth profile of the sediment.

The general procedure for surface water and sediment sampling will be as follows:

- The sampling device will be inserted into the material and removed.
- For wastewater samples, a sufficient quantity of water will be poured directly from the sampling device into appropriate sample containers (refer to QAPP, **Table 3**). The container label will be completed by the sampler as described in Section 5.4.1.
- Water quality measurements of (pH, salinity, conductivity, and temperature) will also be made at the time of sampling.
- For sediment samples, sampled material will be removed from the sampling device and placed into a stainless steel mixing bowl. Prior to placing the sample in the mixing bowl, a sample for VOC analysis, if required, will be collected from the sampling device using a 5-gram or 25-gram Disposable En Core™ Sampler, or equivalent. The sampler will be filled and sealed in accordance with the manufacturer's recommendations.
- The remaining material will be thoroughly mixed with a stainless steel spoon for the purpose of homogenizing the material.
- After mixing, a sufficient quantity of sediment will be placed in appropriate sample containers (refer to QAPP, **Table 3**). The container label will be completed by the sampler as described in Section 5.4.1.
- Field QA/QC samples (refer to QAPP, **Table 1**) for VOC analysis, if required, will be collected at the same time and from the same material as the investigative VOC sample. The remaining duplicate and split samples will be collected from the mixing bowl after the material is homogenized.
- Immediately following collection and labeling, samples will be placed into a cooler with ice or a refrigerator and then transported to the field office for packaging, completion of chain-of-custody documentation, and shipment to the designated analytical laboratory(ies) as discussed in Sections 5 and 6.
- The sampling equipment will decontaminated between each sample location as described in Section 4.10.
- For possible future reference (i.e. location/elevation surveying), the sample location will be marked with a wooden stake or spray paint and labeled with the sample ID.

A Sample Collection Field Sheet will be completed (refer to **Figure 5-2**) and, at minimum, the following information will be recorded:

- Date/time of sampling
- Sampling team members present
- PID/OVA/CGA readings
- Sample location
- Sample number

- Depth to bottom of structure
- Depth of water or sediment where sample was obtained
- Analyses required
- QA/QC sample IDs
- Visual observations, such as free product, sheen, or staining

4.4 CONCRETE FLOOR SAMPLING

Concrete samples will be collected from oil-stained areas inside buildings at locations corresponding to several soil borings . Concrete floor samples will be collected from 0 – 1 inches and 2 – 3 inches below the floor surface as follows:

- At the designated location, the concrete floor will be cored to the appropriate depth using a concrete core sampler with a coring bit of not less than 1 inch in diameter.
- The concrete core sample will then be saw-cut into individual sections corresponding to the sample depth interval.
- The individual core sections will then be placed into the appropriate sample containers (refer to QAPP, **Table 3**) and the container label will be completed by the sampler as described in Section 5.4.1. [Note: Further processing of the samples, such as pulverizing, will be performed by the analytical laboratory.]
- Immediately following collection and labeling, samples will be placed into a cooler with ice or a refrigerator and then transported to the field office for packaging, completion of chain-of-custody documentation, and shipment to the designated analytical laboratory(ies) as discussed in Sections 5 and 6.
- The sampling equipment (core sampler bit and saw blade) will be decontaminated between each sample location as described in Section 4.10.

A Sample Collection Field Sheet (refer to **Figure 5-2**) will be completed, and, at minimum, the following information will be recorded:

- Date/time of sampling
- Sampling team members present
- Sample location
- Sample number
- Depth intervals sampled
- Description of the sample location with sketch, if applicable
- Analyses required
- QA/QC sample IDs
- Visual observation, such as oil-staining

4.5 TEST PIT AND TEST TRENCH EXCAVATION AND SAMPLING

Test pit and trench locations, as shown on **Figures 3-3** and **3-9**, include the areas beneath the foundations of the rotary furnaces in Building 2 and within the former cooling tower base near Building 7. Test pits and trenches will be excavated for purposes of observing subsurface contamination and for sampling soil and/or sediment.

Test pits and test trenches will be excavated with a rubber tire or track-mounted backhoe. Samples for chemical analysis will be obtained from the spoil pile or taken directly from the backhoe bucket using hand tools. Personnel will not enter the test pit or test trench for sample collection purposes. Samples collected from the backhoe bucket for chemical analysis will be obtained from material that has not been in contact with the sides of the backhoe bucket to avoid possible cross-contamination. Samples will be prepared, containerized, stored, and documented as described in Section 4.2 for soil borings. Sampling tools will be decontaminated between each sample and depth interval as described in Section 4.10. The excavator bucket and arm will be decontaminated between test pit/trench locations.

Test pits below the rotary furnace foundations in Building 2 (refer to **Figure 3-3**) will require that the concrete be removed to expose underlying soil. A ram-hoe attachment to the excavator arm will be used to penetrate the concrete. Samples of soil from beneath the foundation ring will initially be collected from the 0 – 6 inch and 4 – 5 foot intervals below the top of the soil. Based on the analytical results from the initial samples, contingency borings may be completed to sample deeper intervals. Contingency soil borings will be completed using a hand auger or small barrel drive sampler according to the procedures discussed in Section 4.2.

A test pit in the area of the former cooling tower near Building 7 (refer to **Figure 3-9**) will initially be excavated to a depth that exposes a layer of sediment derived from cooling tower discharges. This layer is believed to be present at a relatively shallow depth. If the sediment layer is identifiable during excavation, a sample of the material will be collected. Otherwise, a soil sample will be collected from 0 – 6 inches below the top of soil. Test pit excavation will continue to a depth of 5 feet, and an additional sample will be collected from the 4 – 5 foot interval below the top of soil. Based on the analytical results from the initial soil/sediment samples, a trench may be excavated laterally from the test pit to investigate the radial extent of contamination. If this occurs, contingency samples will be collected every 10 feet from the original test pit until sample results indicate the absence of contamination. The contingency samples will be collected from the sediment layer (if identifiable) or 0 – 6 inches and from the 4 – 5 foot interval below the top of soil.

Visual Classification of Soils forms (refer to **Figure 5-4**) will be completed for each test pit and trench and submitted as appendices to the site investigation report. Soil samples will be visually classified in general accordance with ASTM D2488-93, Standard Practice for Description and Identification of Soils (Visual - Manual Procedure). Relevant information to be recorded on the forms is similar to the list of items presented for soil boring logs (refer to Section 4.2).

The test pits and trenches will be backfilled with the excavated soil. If any test pits or trenches are left open overnight, protective rope, construction tape, or other appropriate barricades will be placed around the excavation.

4.6 WIPE SAMPLING

Wipe samples will be collected from the transformer base in the basement of Building 4 and from ventilation ductwork in the hearth room in Building 6. The following is the general wipe sampling procedure to be followed during applicable field activities:

- All undesirable loose material will be removed from the sample collection area.
- A clean, disposable template with an opening of exactly 1 square ft (or 100 square cm for PCBs) will be prepared.
- The template will be secured over the area to be sampled.
- The wipe media will be removed from the box and may only be handled using a new pair of impervious gloves.
- If a damp wipe is required, the wipe media will be moistened with distilled water or appropriate solvent as specified by the analytical laboratory. The type of wipe media used (i.e., glass fiber or paper filter) will also be confirmed with the laboratory.
- The wipe sample will be started at the outside edge of the template and progress toward the center, making concentric squares of decreasing size.
- After completing the sample, the wipe will be folded with the exposed side in, and then folded over again. The wipe will then be placed in a sample container (refer to QAPP, **Table 3**) and the container label will be completed by the sampler as described in Section 5.4.1.
- Immediately following collection and labeling, samples will be placed into a cooler with ice or a refrigerator and then transported to the field office for packaging, completion of chain-of-custody documentation, and shipment to the designated analytical laboratory(ies) as discussed in Sections 5 and 6.
- One blank sample will be created for each sample area by using an unused wipe and preparing the sample, without contacting any surfaces, as described above.
- The disposable template and impervious gloves used to collect the sample will be disposed of after collection of the sample is complete.

A sketch of the sampling area will be included on the Sample Collection Field Sheet (refer to **Figure 5-2**) and/or in the field logbook If possible, the template cutout area will be traced with crayon or marker.

4.7 VIDEO SURVEYING OF SANITARY SEWERS

A video survey of the main sewer lines at SLAAP will be conducted to identify suspected breaches in sewer pipelines that may have historically been potential conduits for releasing contaminants to the subsurface. The video survey will be completed by a subcontractor using closed-circuit television (CCTV) technology, or equivalent. The specific procedures to be followed in the field will be provided in the subcontractor's Standard Operating Procedures. The following are general protocols/criteria for conducting the video survey:

- All electrical components will be designed and constructed to prevent the equipment from igniting flammable or explosive vapors (i.e. explosion-proof equipment).

- The CCTV equipment will be capable of being submersed in water.
- The CCTV will be capable of panning 360 degrees within the pipeline.
- Prior to the video survey, the sewer lines will be checked for obstructions that would interfere with movement of the CCTV equipment. The obstructions shall be removed by water-jetting, bucket scraping, tap cutting (for tree roots), or other appropriate methods.
- The CCTV unit will be advanced through the pipeline by pulling (i.e. winch) or using a self-powered, remote-controlled unit.
- The location of any suspected breaches in a given pipeline will be recorded in linear feet from the point of entry of the CCTV unit.

4.8 REFRACTORY BRICK SAMPLING

The refractor brick associated with the rotary furnaces in Building 2 will be sampled to determine the asbestos content. Small pieces the brick material will be collected by hand, placed into a plastic sample bag, and an appropriate label will be affixed (refer to Section 5.4.1). If present, samples of mortar material will also be collected in the same manner. Sampling personnel will wear new impervious gloves to handle the samples.

4.9 CONTAINERIZED DECONTAMINATION FLUID SAMPLING

Decontamination fluids will be handled and containerized as specified in Section 7 (Investigation Derived Waste). Sampling and chemical analysis of these fluids will be required to evaluate alternatives for disposal. Decontamination fluids will be sampled via an access port at the top of the container (i.e. storage tank or drum) using a decontaminated bottle sampler. The fluid will then be transferred to the appropriate sample containers (refer to QAPP, **Table 3**) and an appropriate label will be affixed (refer to Section 5.4.1). Samples for chemical analysis will be placed into a cooler with ice or a refrigerator within 5 minutes of collection and then transported to the field office for packaging, completion of Chain-of-Custody documentation, and shipment to the designated analytical laboratory(ies) as discussed in Sections 5 and 6. A Sample Collection Field Sheet (refer to **Figure 5-2**) will be completed and, at minimum, the following information will be recorded:

- Date/time of sampling
- Sampling team members present
- Sample number
- Quantity of decontamination fluid in container
- Location of container sampled
- Contents of container(s) sampled
- Analyses required

4.10 EQUIPMENT DECONTAMINATION

Decontamination of equipment will be performed to avoid cross-contamination of samples collected for chemical analysis, and to limit the migration of contaminants off-site and between on-site work areas. Decontamination of soil boring, coring, excavating, and sampling equipment will occur at the exclusion zone of the intrusive activities or at central decontamination stations (if required).

Equipment will be inspected when it arrives on site for evidence of gross contamination (excessive mud or grease). If gross contamination is present, the equipment will either be returned to the vendor for cleaning or cleaned on-site. Following the initial inspection, equipment will be decontaminated at the location of the first activity. Final decontamination of drill rigs and excavation equipment will be conducted at the location of the last activity or at a central decontamination station. All reusable equipment that may come in contact with samples for chemical analysis will be decontaminated between collection of samples.

Decontamination will consist of scraping and scrubbing to remove encrusted materials, if necessary, followed by a soap (nonphosphate detergent) and water wash and then a potable water rinse. Alternatively, the equipment may be cleaned with a high-pressure hot water/steam cleaning unit. Sampling equipment will then be rinsed with analytical grade heptane followed by rinsing with deionized/distilled water.

Test trench excavation equipment (i.e., excavator bucket) and sampling equipment will be decontaminated between each trench location. Decontamination will take place at or near each trench location. Decontamination will be accomplished with a high pressure hot water/steam cleaning unit.

5.1 FIELD LOGBOOK

The field logbook will consist of a hard bound, water-resistant field book with numbered pages. All pertinent information regarding the site and sampling procedures will be documented in indelible ink. Notations will be made in logbook fashion with sufficient detail so that decision logic may be traced once reviewed, noting the time and date of all entries. One logbook will be assigned to each sampling team. The following information will be included in the field logbook:

- Project name and number, date, and page number at the page top
- Weather conditions, temperature, wind speed and direction and weather forecast for the day
- Name and task related title of each one of the team members present on-site
- Name and task related title of each subcontractor present on-site
- Name and title of any client representative, oversight personnel, or visitor
- Information concerning activity/sampling changes, schedule modifications, or change orders
- Deviations from approved work plans
- Results from any health and safety monitoring, and any necessary actions
- Information concerning access agreements or conversations with property owners
- Sketches and field measurements of sample locations
- Field observations
- Chronology of events
- Location, description, compass direction, date, and log of photographs
- Sample ID number(s) of all samples collected
- Other information which the author believes is important to document

At the end of each day, all field personnel maintaining a logbook will cross through the remaining space of the last page of the logbook for that day's activities, sign and date it.

The field manager or sample manager may also maintain a field logbook for recording the information presented above or for documenting other relevant information.

5.2 PHOTOGRAPHS

At each sampling location, a color photograph will be taken which shows the sampling location and its immediate surroundings. Included in each photograph will be a placard of known dimensions. The placard will be marked with information indicating which building and which portion or feature of a building the photograph is depicting. The location, description, compass direction, date, and log of each photograph will be recorded into the field logbook.

Photographs of other items of interest, such as samples, physical features, field equipment, and others, may be taken at the discretion of field personnel. Photographs of individual samples will

include a placard marked with the investigation and location identifiers, and the 2-digit sample location and 3-digit sample depth (if applicable) identifiers (see Section 5.3).

5.3 SAMPLE NUMBERING SYSTEM

All samples will be identified with a unique sample ID which identifies the as described below.

5.3.1 Site Characterization Samples

The sample identification system for samples to be used for site characterization, not the risk assessment, is described below.

Format: $\#\#_B$XX-$\#\#_S$-MMYYQQQ

Where each element of the sample ID represents the following identifying information:

$\#\#_B$: Two-digit number representing the building or area of concern

examples: 01 = Building 1

02 = Building 2

NE = Northeast parking area

SR = Sewer system

RR = Railroad

RD = Roadway

BK = Regional background area

IW = Investigation derived waste

XX: Two-character sample type code

SB = Soil Boring

CS = Concrete

SW = Surface Wipe

SD = Sediment

WW = Wastewater

AC = ACM sample

TX = Test Pit, where X represents sample media as follows

E = Encrusted deposits

D = Sediment

S = Soil

C = Concrete

P = Product

W = Water

examples: TC = concrete sample from a test pit

TS = soil sample from a test pit

$##_S$: Two-digit sample number

For all samples except soil borings:

01 = 1st sample of a given type at a given building

02 = 2nd sample of a given type at a given building

Soil Borings: $##_S(##_T\text{-}##_B)$

$##_S$ = Soil boring number

$##_T$ = Top of sample depth range

$##_B$ = Bottom of sample depth range

example: 02(09-10) = 2nd soil boring, 9-10 ft depth interval

MMYY: Date of sample collection

MM = month

YY = year

example: 0901 = sample collected in September 2001

QQQ: QAQC Type of sample

omitted = Investigative Sample

DQC = Contract Laboratory QC Duplicate Sample

DQA = CEWES QA Duplicate Sample

RIN = Rinsate Sample

MS = Matrix Spike Sample

MSD = Matrix Spike Duplicate Sample

Site Characterization Sample ID Examples

01SB-03(05-06)-1101	5-6 foot depth interval in the 3rd soil boring collected in Building 1 during November 2001
01SB-03(05-06)-1101RIN	Rinsate sample of equipment used to collect the above sample
SRSD-15-1101	15th sediment sample collected from the sewers in November 2001
02TC-02-1201	Concrete sample from the second test pit sampled in Building 2 in December 2001

5.3.2 Risk Assessment Samples

Although risk assessment samples and site characterization samples will be collected with the same techniques in the field, the risk assessment samples will have sample ID's which distinguish them from the site characterization samples.

Format: Identical to site characterization samples, but with an "RA-" appended to the beginning of the ID

Risk Assessment Sample ID Examples

RA-01SB-03(05-06)-1101	5-6 foot depth interval in the 3rd risk assessment soil boring collected in Building 1 during November 2001
RA-01SB-03(05-06)-1101DQC	Duplicate of the above sample

5.3.3 Trip Blank Samples

Since trip blanks packed with other samples for shipment to the laboratory are unique, they will be assigned unique sample ID's.

Format: TRB-XX##-MMDDYY

Where each element of the sample ID represents the following identifying information:

TRB: Common designation for all trip blank samples

XX: Two-character designation for the laboratory to which the samples were sent

CS = CEWES

Other laboratories to be designated upon their selection

##: Two-digit shipping container number

01 = 1st container of VOC samples sent to the laboratory on a given day

02 = 2nd container of VOC samples sent to the laboratory on a given day

MMDDYY: Date trip blank is sent to laboratory

MM = month

DD = day

YY = year

example: 110501 = November 05, 2001

Trip Blank Sample ID Examples

TRB-CS01-120201	1st trip blank sent to CEWES on December 02, 2001
TRB-LB04-112301	4th trip blank sent to a lab designated as "LB" on November 23, 2001

5.4 SAMPLE DOCUMENTATION

Sample documentation will include:

- Field logbook
- Sample collection field sheets
- Sample labels
- Chain-of-Custody (COC) forms
- Custody seals
- Receipt-for-sample form
- Cooler receipt forms

The field leader or sample manager will be responsible for reviewing the information contained in the sample collection field sheets and logbook, and the preparation of the COC forms. The field leader will also be responsible for keeping the field project file, contact with contractual and owner's analytical laboratories, and contact with equipment and field suppliers.

All original data recorded in the field logbooks and on sample labels, sample collection field sheets, and COC forms will be written in waterproof ink. If an error is made on an accountable document, corrections will be made simply by crossing out the error with one line and entering the correct information. The erroneous information will not be obliterated. Any error discovered on a document will be corrected by the person who made the entry. All corrections will be initialed and dated.

5.4.1 Sample Labels

Adhesive sample labels for the identification of each sample collected will be pre-printed and they will include the following information:

- Label heading: "URS Group, Inc., SLAAP Site-Specific EBS (49-F0K96219.01), St Louis, MO"

- Sample identification number (e.g. 01SB-03(05-06)-1101)
- Sampler initials (to be filled in at the time and date of sampling)
- Date/Time (to be filled in at the time and date of sampling)
- Sample matrix
- Chemical analysis to be performed
- Sample Container and Preservative (if any)
- Analytical laboratory

A fine point permanent marker will be used to fill the blanks on the sample labels. Labels will be protected with a coat of wide clear tape once all information is complete and before sample containers are filled. An example of labels to be used in the field is provided in **Figure 5-1**.

5.4.2 Sample Collection Field Sheets

Sample collection field sheets will be used to record all sample information including:

- Sample identification number
- Sampler(s)
- Date and time of sample collection
- Sampling methodology (e.g. hand auger) and sample type (e.g. subsurface soil), and sample matrix (e.g. soil)
- Analysis requested and sample preservation
- Approximate volume of sample collected

Sample collection field sheets will be initially placed in a plastic bag with sample containers in a chilled cooler. Sample collection field sheets will be filled out with complete information at the time of sampling. **Figure 5-2** presents an example of a sample collection field sheet.

Each sample will be documented on the sample collection field sheets, and all paperwork will be returned with the samples to the sample manager. The sample manager will log the samples in the COC forms for shipment to the laboratory for analysis.

5.4.3 Chain-of-Custody Records

Logging of the samples into the COC forms will be performed using Site Manager Pro (SMPro). SMPro is a Microsoft Windows-based data management software used to implement the sampling plan and prepare COC forms in the field. A typical COC form is presented in **Figure 5-5**.

Once the samples are logged into SMPro, a COC form will be printed out and placed into the cooler with the corresponding samples for shipment to the laboratory. A copy of the COC forms will be kept by the sample manager.

COC numbers are entered as a data field in SMPro. These numbers are generated using the following elements: year, month, day, analytical laboratory designator, and shipping piece

number sequence for the day. An example of a COC number for USACE Chemistry Quality Assurance Branch of the Waterways Experiment Station Environmental Laboratory (CEWES), cooler three, shipped on November 5, 2001 will be identified as: 011105CEWES03. Analytical laboratory designators for contract laboratories will be established after the contract laboratories have been selected.

Additional information to be transferred onto the COC is as follows:

- Project name and number
- Project location
- Project manager
- Sampler's initials
- COC number
- A complete list of analyses, with specific selection of the requested analysis
- Sample date and time
- Sample type and matrix
- Number of sample containers
- Sample identification
- Sample manager signature
- Date and time of sample release to courier or shipper
- Airbill number
- Laboratory address
- Laboratory subcontract number

The temperature blank will be hand-written to the COC form. Prior to sealing the COC form in the individual sample cooler, the sample manager will sign and date the COC form, relinquishing the samples to the laboratory. The COC form will then be placed inside a plastic zip-lock type bag and the bag will be taped to the inside lid of the cooler.

5.4.4 Custody Seals

Custody seals are used to ensure that sample packages have not been opened during shipment. The following information will be included on the custody seals applied to the front and back of each cooler:

- Signature of the sample custodian
- Date when the sample package was sealed

5.4.5 Cooler Receipt Forms

A cooler receipt form (**Figure 5-6**) will be filled out by the laboratory sample custodian on each cooler received. The purpose of this form is to obtain cooler receiving conditions and sample log-in information. URS will supply these forms prior to any sampling activities. Completed cooler receipt forms will be kept with COC forms.

5.5 DOCUMENTATION PROCEDURES

Steps for documenting sample collection during the field work are as follows:

1. Enter into the field logbook the date and time, the location identification, sampling team personnel present, weather conditions, and other pertinent information regarding field activities.
2. Complete the sample collection field sheet.
3. After sample collection, lids for each sample container will be secured and samples stored with ice or frozen, reusable chemical packs in an insulated cooler to maintain sample temperature of approximately 4°C.
4. The Chemical Quality Control (CQC) Representative or his designee will fill out the COC form by recording sampling information directly from the labels on the sample containers. The sample collection field sheets will not be used to fill out the COC forms. Each sample container label will be checked for completeness.
5. When the COC form(s) and the sample collection field sheet(s) are completed, a photo copy(s) will be made and placed in the project file.
6. Sample packaging procedures are described in Section 7.1.
7. The sample container air bill will be completed with the name, address, company, and phone numbers of the sender and the recipient. The air bill will be marked for priority overnight delivery when shipments are sent on Monday through Thursday. The air bill will be marked for Saturday delivery when shipments are sent on Friday. Payment will be marked by checking the box labeled "Sender". The internal billing reference number will be placed on the air bill.
8. When the air bill is completed, a photocopy of the form will be made and placed in the project file.
9. The day after a sample shipment, the sample manager will contact the laboratory to confirm that all shipped samples have arrived and are in satisfactory condition. The last three columns of the sample tracking field sheet will be completed for the samples that were shipped the previous day.

5.6 CORRECTIONS TO DOCUMENTATION

All original data recorded in the field logbooks, sample labels, sample collection field sheets, and chain-of-custody forms will be written in waterproof ink. If an error is made on an accountable document, corrections will be made simply by crossing out the error with one line and entering the correct information. The mistaken entry will not be covered up, "whited out", or erased.

Any error discovered on a document will be corrected by the person who made the entry. All corrections will be initialed and dated.

This section describes procedures for properly handling and shipping the environmental samples collected at the site. The procedures described in this section are performed after samples have been collected, placed in the proper containers and correctly preserved.

6.1 SAMPLE STORAGE

Upon collection of the samples, they will be placed in a cooler with ice and transported back to the field office by either the sampling team or the sample manager. At the field office, all individual sample containers will be placed in plastic zip-lock bags. Four 40 milliliter VOC vials (which constitutes one sample) will be placed into a zip-lock bag. An ice bath will then be prepared by placing several bags of ice in a plastic tub and then adding some water. The sample containers will then be partially submerged in the ice bath along with one temperature blank per tub of samples. Samples will remain in the ice baths until packing.

6.2 SAMPLE PACKING

All samples collected will remain in the possession of the sampling crew until shipment. Locked vehicles, buildings or trailers will be used for interim storage as necessary. If coolers used for sample storage must be left unattended for extended periods of time, signed custody seals will be placed on the coolers.

Once the COC forms are printed and signed, one copy of this document will be made. The copy will be used as a packing list for each cooler. A detailed comparison between each sample label and the entries on the COC form will be made to ensure accuracy. Any discrepancy should be corrected by following the guidelines in Section 5.6. This practice is a QC mechanism to ensure that all samples are placed in the cooler for shipment and that all paperwork is accurate.

COC records for CEWES will also have the appropriate laboratory information management system (LIMS) numbers in the remarks box on the lower right hand corner of the COC form. The LIMS number for this sampling event will be provided by CEWES.

Sample packing will begin by preparing a portable insulated container (cooler) for use as the shipping vessel. Old shipping tags, labels, and any other markings from previous shipments will be removed from the cooler. The inside of the cooler will be wiped out with a paper towel wetted with deionized water. A layer of styrofoam sheeting or bubble wrap will be placed in the bottom of the cooler to cushion the samples. A large plastic garbage bag will be used as a liner for the cooler.

VOC vials will be wrapped in packing foam or bubble wrap and then placed in a plastic zip-lock bag. Two VOC trip blank vials will be shipped in each sample cooler containing VOC samples. The trip blanks will be appropriately labeled, wrapped with one set of VOC samples, and then inserted into the same plastic bag as the set of samples. Sample containers will then be placed upright in the lined cooler in such a way that they will not touch each other during shipment. Packing material such as bubble wrap will be placed between the bottles at the discretion of the sample custodian. A 40 ml temperature blank supplied by each laboratory will be included in the cooler.

All samples will be shipped to the laboratory on ice. Ice in double-lined bags will be placed around, and on top of the sample containers. If pre-frozen blue ice is used, it will be carefully

placed inside the cooler to avoid direct contact with glass ampule containers. Additional inert packing material will be placed in the cooler. The signed COC form will be placed inside a plastic zip-lock type bag and taped to the inside lid of the shipping cooler. The cooler will then be closed and taped shut with filament-type strapping tape.

At least two signed custody seals will be placed on the cooler and taped over, one on the front and one on the side. Additional seals may be used as needed. The shipping information will be affixed on the top of the cooler. The cooler will be handed over to the local courier or delivered directly to the shipper by a sampling team member.

6.3 SAMPLE SHIPPING

Sample containers will be delivered to the shipping company by a local courier or a sample team member. Air bills will be pre-typed with information regarding analytical laboratory address (destination), contact person and phone number, sender address, name and phone number, and project and task number. The type of services required from the delivery company will also be marked appropriately (i.e., next day morning delivery, weekday delivery except for Friday shipment that should be marked for SATURDAY DELIVERY).

In addition to the shipping labels, a pre-typed label will be taped on the cooler top with both the sender and receiver addresses on them. Proper warning labels will be placed on the cooler to advise shipper of the presence of breakable containers in the cooler.

6.4 LABORATORY SAMPLE RECEIVING

Upon receipt of the sample coolers at the appropriate laboratory, the laboratory will check the following items:

- The cooler will be checked for damage or leakage and custody seals will be verified to be intact
- Contents of each cooler will be compared with the COC to verify that all sample ID and requested analyses match and that no samples are missing
- Bottles will be inspected for breakage or leakage
- The temperature of the sample and the temperature blank will be measured and recorded on the COC form
- The pH of liquid samples will be measured (to verify proper pH) and recorded
- Any discrepancies between cooler contents and COC forms will be noted and/or comments provided regarding damaged samples or problems in the "remarks" section of COC form
- Cooler receipt forms (**Figure 5-6**) provided by URS will be filled out and included in the laboratory's hard copy report
- The URS Chemical QA Officer will be contacted immediately regarding problems with a sample.

Laboratory analyses of all samples will be performed by contract laboratories which have not yet been identified and the Waterways Experiment Station. Addresses and points of contact for these laboratories are provided below.

Analytical Laboratory	Analysis	Address	Contact Person	Phone Number Fax Number
CEWES	VOCs, Explosives, Metals, SVOC's, Pesticides, Inorganics	420 S. 18th Street Omaha, NE 68102	Laura Percifield Shelly Swink	(402) 444-4314 (402) 444-4318
Contract Laboratory(s) To Be Determined	VOCs, Explosives, Metals, SVOC's, Pesticides, Inorganics, ACM			

IDW generated during project activities will include decontamination (rinse) water, soil from soil borings and sediment sampling, concrete from concrete sampling, disposed debris and soils from test pit excavation, and personal protective equipment (PPE). General procedures for managing IDW are as follows:

- Decontamination fluids and fluids generated during sampling activities will be containerized in a holding tank or in 55-gallon drums. Containerized decontamination fluids will be labeled and inventoried. Labels will, at a minimum, define the contents, the date the IDW was collected, and the reason for containerization. An up-to-date container inventory will be maintained on site that documents the type of container, the contents of the container, date of arrival at storage area, and the container status (e.g., awaiting analytical results). In addition, routine visual inspections of the storage area will be made to identify areas of potential leaks or spills. At the conclusion of the field sampling activities, samples of the containerized fluids will be submitted to the analytical laboratory for analysis of PCBs, SVOCs, and total metals as discussed below.
- Unused portions of soil samples will be returned to the sampling location (i.e. placed back into the bore hole or sediment location).
- Unused portions of concrete from concrete samples and miscellaneous concrete cuttings will be placed back into the core holes from which they were collected.
- Disposed debris, soils and concrete from test pit excavations will be returned to the test pit as backfill material.
- PPE will be placed in plastic trash bags and disposed as municipal waste.

Decontamination fluids will be sampled according to the procedures outlined in Section 4.9. Final disposition of the containerized IDW will be determined based on the results of the laboratory analysis.

During field activities, Daily Chemical Quality Control Reports (DCQCRs) will be prepared daily, dated, signed by the Chemical Quality Control Representative or his designee, and sent to the URS project manager (See **Figure 8-1**). The DCQCR will include the following information:

- Weather information at the time of sampling
- Field instrument measurements
- Calibration
- Problems
- Deviations that may affect data quality objectives
- QA/QC sample tables
- Copies of COC forms

This section discusses corrective action procedures to be followed in the event that a discrepancy is discovered by field personnel, field auditors, and/or laboratory personnel. Typical discrepancies include improper sampling procedures, improper instrument calibration procedures, improper sample preservation, and problems (e.g., broken jar, missing label, etc.) with samples upon receipt at the laboratory.

The Chemical Quality Control (CQC) Representative will be responsible for the implementation of the FSP procedures. In the event of any improper sampling procedure, the CQC Representative will ask the sampling team to immediately comply with this FSP and will document the discrepancy and circumstances, and will direct the sampling team to re-collect samples (if necessary) under the proper protocol.

Instruments will be calibrated and maintained according to manufacturer recommendations. A list of the instruments required is shown in **Table 9-1**. The instrument calibration logbook will be inspected daily by the CQC Representative, or his designee. Any instrument problems will be immediately reported to the CQC Representative. It will be the responsibility of the CQC Representative to make arrangements to replace the instrument with another one in proper working condition. Improper instrument calibration and corrective action will be documented in the logbook and reported in the DCQCR.

Sample preservation procedures in the field will be supervised by the CQC Representative, or his designee. Laboratory pre-preserved containers will be inspected by the CQC Representative, or his designee. In the event that any sample container has an incorrect or insufficient amount of preservative, the sample container will be discarded and a new sample container and label will be provided by the CQC Representative, or his designee. In the event of sample container breakage or leakage in the field, new samples will be collected. Proper documentation will be completed by the CQC Representative, or his designee, to document the circumstances. This documentation will be part of the field project file.

Problems with samples after receipt at the laboratory will be addressed by the CQC Representative. In the event of discrepancies between the COC and the sample labels, corrections will be made according to procedures described in Section 5.6. If sample containers are broken or if a sample container is missing from the cooler, the laboratory will notify the CQC Representative, or his designee, who will arrange for a new sample to be collected. Proper documentation will be attached to the original sample field sheets and the original COC form to document the corrective action.

Any other deviation from Part I of this SAP will be initially reported to the CQC Representative who is responsible for reporting the details in the DCQCR.

A proposed schedule for the field sampling and report preparation activities is presented in below. Due to the anticipated start date for the field effort in early November 2001, the schedule takes into account holiday periods in November, December and January.

Activity/Task	Calendar Days to Complete
Field Work Preparation	Completed within 5 days from Approval of Work Plans
Field Mobilization	3 days
Field Work - Initial	30 days
Field Work – Contingency Samples	Started within 2 days of receipt of initial analytical results; completed within 21 days from receipt of analytical results for initial samples
Demobilization	3 days
Chemical Analysis Completed	14 days after laboratory receives final samples
Data Validation Completed	14 days from receipt of final analytical results
Draft Report	30 days from receipt of final analytical results
Review/Comments on Draft Report	14 days
Final Report	30 days from receipt of review comments

American Society for Testing and Materials (ASTM). 1996a. *ASTM Method 6008-96, Standard Practice for Environmental Baseline Surveys.*

ASTM. 1996b. ASTM Method 1527-97, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.*

Environmental Data Resources, Inc. (EDR). 1999. *St. Louis Army Ammunition Plant, St. Louis, Missouri.* Inquiry number: 338266.3S. Feb.

Missouri Department of Conservation. 1993. Letter Regarding Endangered Species and Other Sensitive Environmental Concerns in the Vicinity of the St. Louis Army Ammunition Plant (SLAAP). From Dan F. Dickneite, Planning Division Chief. To Larry E. Wright, Department of the Army. 29 Dec.

Missouri Department of Natural Resources (MDNR). 1994. Letter Regarding SLAAP Structure Status. To U.S. Army Aviation and Troop Command (ATCOM), Administrative and Installation Support Activity. Jefferson City, Missouri. 21 Jan.

Tetra Tech EM, Inc. (TTEMI). 2000. *Final Environmental Baseline Survey Report, St. Louis Army Ammunition Plant, St. Louis, Missouri.* 28 Dec.

U.S. Army Environmental Hygiene Agency (USAEHA). 1993. *Preliminary Assessment Screening No. 38-26-K19X-93, St. Louis Army Ammunition Plant, St. Louis, Missouri.* Jan.

U.S. Army Toxic and Hazardous Materials Agency (USATHMA). 1979. *Installation Assessment of St. Louis Army Ammunition Plant.* Report No. 153. Dec.

U.S. Environmental Protection Agency (USEPA). 1992. *Guidance for Data Useability in Risk Assessment (Part A).* April.

U.S. Environmental Protection Agency (USEPA). 1996. *Soil Screening Guidance: Technical Background Document.* May.

Woodward-Clyde Consultants. 1985. *An Archeological Overview and Management Plan for the St. Louis Army Ammunition Plant, St. Louis County, Missouri.* Apr.

Table 1-1. Summary of Physical Features for Building 1

Building Characteristics	
Building Name	Billet Cutting Building
Area	8,770 square feet (ft^2)
Style	One story
Construction Materials	Steel frame and roof truss building with corrugated asbestos siding. The floor is reinforced concrete. The roof is precast concrete slab deck with a pitch felt and gravel surface.
Construction Date	Built in 1944
Historical Use	
Occupants/Lessees	1944 to 1983: SLAAP (105-millimeter (mm) Howitzer shell production)
Operational Periods	1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production
Historical Processes	
Process Summary	Steel billets were stored in concrete and H-beam racks outside of the eastern and western sides of Building 1. Long 4-inch square steel billets or bars were fed into the building via conveyor systems to four nicking machines (two on the east and two on the west sides). Each nicking machine consisted of eight oxygen-assisted acetylene torches that would create a nick approximately 1/4" deep and 3/16" wide along the width of each bar. Following nicking, conveyor feeds would move the billets through a direct-contact water cooling process to eight breaking machines (each rated for 530 slugs per hour). Billet ends from each end slug were cut to size in cold saw machines. Snag grinding, as necessary, was completed on all breaks that did not meet specifications. Following inspection, the finished 8-1/2" slugs were mounted on skids and transported to the forge building (Building 2).
Process Machinery	Process machinery included conveyor tables, billet nicking machines, conveyer systems equipped with water sprays, hydraulic breaking presses, cold saws and a saw sharpener, snag grinders, fume exhaust fans, a dust collector, self-propelled electric cranes, unit ventilators, pits under hydraulic breaking machines, pits with process water discharge, and a pit with an acetylene drip pot.
Process Utilities	Water, steam, compressed air, acetylene gas, oxygen gas, and electricity.
Hazardous Material Information	
Possible Hazardous Material Used	Acetylene, quench water, cooling oil, hydraulic fluids, and machine lubricants.
Hazardous Material Storage and Usage Areas	Pits under hydraulic break machines, two pit with process water discharge, and a pit below the acetylene drip pot
Hazardous Material Off-Loading Areas	A loading dock is present along the northern side of the building.

Table 1-2. Summary of Physical Features for Building 2

Building Characteristics	
Building Name	Forge Building
Area	First Floor: 73,095 ft² Second Floor (Switching Room): 792 ft² Third Floor (Machine Balconies): 2,964 ft² Fourth Floor (Catwalks): 1,803 ft² Fifth Floor (Locker Rooms): 1,701 ft²
Style	Five stories
Construction Materials	Steel frame and roof trusses on reinforced concrete piers, corrugated asbestos siding, and an asbestos-covered metal roof.
Construction Date	1944
Historical Use	
Occupants/Lessees	1944 to 1983: SLAAP (105-mm Howitzer shell production)
Operational Periods	1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production
Historical Processes	
Process Description	The building contained 10 gas- and oil-fired rotary furnaces for slug heating and forging. Cut steel billets from Building 1 were forged into hollow cylinders. After forging, the billets were cooled by water spraying and quenching. Various hydraulic systems were also used in the production process.
Process Machinery	Rotary furnaces, piercing presses, sizing and de-scaling units, hydraulic draw benches, conveyors, accumulators, air hammers, cooling tanks, oil heaters, cranes, metal grinders, transformers, and air compressor motors and cylinders.
Process Utilities	Electricity, water, fuel oil, compressed air, steam, and natural gas.
Hazardous Material Information	
Possible Hazardous Material Used	Hydraulic and fuel oils, solvents (toluene), asbestos, LBP, quench water, and machine lubricant oils
Hazardous Material Storage and Usage Areas	First Floor: A fuel oil distribution system, hydraulic oil systems, and cooling tanks Second Floor: Two transformers and switches Outside: A 10,000-gallon regular (leaded) gasoline UST and dispenser (abandoned and filled with sand in 1959; removed in 1992)
Hazardous Material Off-Loading Areas	The UST was filled using a fill port on top of the tank. Fuel oil was off-loaded into pipes contained in loading pits. These pits were located north of Building 2 from 1944 to 1958 and east of the building from 1958 to 1969.

Table 1-3. Summary of Physical Features for Building 3

Building Characteristics	
Building Name	Machining Building (also known as Building 202ABC)
Area	Basement: 37,000 square feet (ft^2) First Floor: 168,000 ft^2 Second Floor: 154,780 ft^2 Penthouse: 6,813 ft^2
Style	Two stories, basement, and two penthouses
Construction Materials	Steel frame and roof beams on reinforced concrete piers and spread footings; masonry walls; and a prefabricated concrete roof. The eastside addition has the same structure, but also is covered with asbestos siding.
Construction Date	Built in 1941, retooled (including eastside addition) in 1944. Renovated to create office space in 1984 and 1985.
Historical Use	
Occupants/Lessees	1941 to 1944: SLOP (0.30-caliber munitions production) 1944 to 1983: SLAAP (105-millimeter (mm) Howitzer shell production) 1985 to 1996: SLAAP (AVSCOM office space)
Operational Periods	1941 to 1944: 0.30-caliber munitions production 1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production 1985 to 1996: Office space
Historical Processes	
Process Description	Processes completed in Building 3 consisted of shell shaping, heat tracing, cleaning, painting, and packaging for shipment. Metal chips and fragments produced as a result of the shell machining processes were collected on the first and second floors and disposed in the chip chute. The chip chute is an open chute along the north wall that opened to the basement in Building 3. From the basement, the metal chips were transferred to a railcar via conveyor for off-site disposal.
Process Machinery	Process machinery included lathes, drill presses, milling machines, grinders, heat-treating furnaces, wash racks, welders, shapers, shot-blasting equipment, paint spray booths, transformers, air compressors, and auxiliary equipment (dust collection devices, elevators, and conveyors).
Process Utilities	Water, steam, compressed air, soluble oil, quench oil, paint, natural gas, telephone service, and electricity.
Hazardous Material Information	
Possible Hazardous Material Used	Cutting (soluble) oil, quench oil (No. 6 fuel oil), hydraulic oil, solvents (toluene), asbestos, lead-based paint, and pesticides.
Hazardous Material Storage and Usage Areas	Basement: Chip chute, 6-inch diameter quench oil lines to sludge tank, transformer vaults, quench oil pump station First Floor: Cutting oil distribution system, soluble oil and mixing room, 14 quench oil tanks, paint storage room, hydraulic oil reclaiming unit, five wash racks, five paint spray booths, paint stripping room. Second floor: Cutting oil distribution system, heat treating quench oil.
Hazardous Material Off-Loading Areas	The quench oil USTs at Building 8 had remote fill capability from railroad tracks on the northeast side of Building 3.

Table 1-4. Summary of Physical Features for Building 4

Building Characteristics	
Building Name	Air Compressor Building
Area	Basement: 2,772 ft² First Floor: 8,450 ft²
Style	One story with basement on the western side
Construction Materials	Steel frame and roof beams on reinforced concrete piers and spread footings and has corrugated asbestos siding and roof.
Construction Date	1944
Historical Use	
Occupants/Lessees	1944 to 1983: SLAAP (105-mm Howitzer shell production)
Operational Periods	1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production
Historical Processes	
Process Description	Housed air compressors used to generate compressed air for processes performed in the other SLAAP buildings.
Process Machinery	Compressor motors and cylinders, intercoolers, aftercoolers, and air receivers.
Process Utilities	Electricity, water, compressed air, and steam.
Hazardous Material Information	
Possible Hazardous Material Used	ACM, LBP, and hydraulic and motor oils
Hazardous Material Storage and Usage Areas	Two transformers
Hazardous Material Off-Loading Areas	None

Table 1-5. Summary of Physical Features for Building 5

Building Characteristics	
Building Name	Headquarters and Office Building (also known as Building 202D)
Area	Basement: 1,153 ft² First Floor: 11,662 ft² Second Floor: 10,075 ft² Penthouse: 392 ft²
Style	Two stories with basement and penthouse
Construction Materials	Steel framework with reinforced concrete (brick-covered) walls and piers with spread footings. The floors are reinforced concrete. Some corrugated asbestos siding was used on certain walls. The building has a pre-cast concrete roof with insulation board underneath.
Construction Date	Built in 1941, altered in 1944 to office space. Renovated and upgraded in 1984.
Historical Use	
Occupants/Lessees	1941 to 1944: SLOP (primer building) 1944 to 1983: SLAAP (office space) 1962 to 1967: Futura Manufacturing Company (assembly of radios) 1985 to 1996: SLAAP (AVSCOM office space)
Operational Periods	1941 to 1944: Primer loading 1944 to 1945: Office space 1952 to 1954: Office space 1962 to 1967: Assembly of pocket-sized radios 1966 to 1969: Office space 1985 to 1996: Office space
Historical Processes	
Process Description	Served as a primer loading plant for 0.30-caliber ammunition from 1941 until 1944, when the machinery was removed and office space renovations were conducted. This building was also leased from 1962 to 1967 to the Futura Manufacturing Company for assembly of pocket-sized radios.
Process Machinery	Small arms ammunition loading machinery until 1944, an elevator, and steam unit heaters.
Process Utilities	Water, steam, telephone service, and electricity.
Hazardous Material Information	
Possible Hazardous Material Used	Hydraulic oil, ACM, LBP, cleaners, transformer oil, primers, solvents, metals, and light ballasts
Hazardous Material Storage and Usage Areas	Transformers, light ballasts, and oil storage outside
Hazardous Material Off-Loading Areas	None

Table 1-6. Summary of Physical Features for Building 6

Building Characteristics	
Building Name	West Office and Laboratory Building (also known as Building 202E)
Area	Basement: 1,153 ft² First Floor: 9,825 ft² Second Floor: 10,477 ft² Penthouse: 118 ft²
Style	Two stories with basement and penthouse
Construction Materials	Steel framework with reinforced concrete (brick-covered) walls and piers with spread footings. The floors are reinforced concrete. Some corrugated asbestos siding was used on certain walls. The building has a pre-cast concrete roof with insulation board underneath.
Construction Date	Built in 1941, altered in 1944 to office space.
Historical Use	
Occupants/Lessees	1941 to 1944: SLOP (small arms primer insert building) 1944 to 1983: SLAAP (office space and laboratory) 1985 to 1996: SLAAP (AVSCOM office space)
Operational Periods	1941 to 1944: Small arms primer insertion 1944 to 1945: Office and laboratory space 1952 to 1954: Office and laboratory space 1966 to 1969: Office and laboratory space 1985 to 1996: Office space
Historical Processes	
Process Description	Utilized for small arms primer insertion from 1941 until 1944, when the machinery was removed and office space renovations were conducted. A metallurgical laboratory occupied a small part on the first floor and performed quality control testing. Operations included polishing, measuring, and some etching.
Process Machinery	Small arms primer insertion machinery, ventilators for the laboratory, a dark room, radiators, and steam unit heaters.
Process Utilities	Water, steam, telephone service, and electricity.
Hazardous Material Information	
Possible Hazardous Material Used	Small amounts of unidentified laboratory chemicals and solvents as well as hydraulic oil, ACM, LBP, cleaners, transformer oil, and light ballasts.
Hazardous Material Storage and Usage Areas	Transformers, light ballasts, and the laboratory
Hazardous Material Off-Loading Areas	None

Table 1-7. Summary of Physical Features for Buildings 7 and 7A

Building Characteristics	
Building Name	Water Pump House (Bldg. 7) and Cooling Tower (Bldg. 7A)
Area	Building 7 1,048 ft² Building 7A 635 ft²
Style	Building 7 is one story, cooling tower was 15 feet tall (demolished).
Construction Materials	Building 7 is constructed of concrete block walls, a reinforced concrete floor on a reinforced concrete slab, and a tar and gravel roof. The cooling tower is a wooden frame tower on a concrete base.
Construction Date	1944
Historical Use	
Occupants/Lessees	1944 to 1983: SLAAP (105-mm Howitzer shell production)
Operational Periods	1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production
Historical Processes	
Process Description	Building 7 housed water pumps used to circulate process (coolant) water between Buildings 2 and 4. A cooling tower (Building 7A) was located east of Building 7.
Process Machinery	Water pumps and piping
Process Utilities	Electricity, water, compressed air, and steam.
Hazardous Material Information	
Possible Hazardous Material Used	ACM and LBP in Building 7. Hexavalent chromium associated with the cooling tower.
Hazardous Material Storage and Usage Areas	None
Hazardous Material Off-Loading Areas	None

Table 1-8. Summary of Physical Features for Buildings 8 and 8A

Building Characteristics	
Building Name	Fuel Storage Area (Bldg. 8) and Oil Pumphouse (Bldg. 8A)
Area	Building 8 1,048 ft² Building 8A 635 ft²
Style	The Fuel Storage Area is a square area bounded by earthen dams on three sides and a natural slope on the fourth. The Storage Area was divided into three equal sections by walls. Building 8A is one story.
Construction Materials	Building 8 had concrete block walls and earthen dams. Building 8A has concrete block walls, a reinforced concrete slab floor, and a tar and gravel roof.
Construction Date	1944
Historical Use	
Occupants/Lessees	1944 to 1983: SLAAP (105-mm Howitzer shell production)
Operational Periods	1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production
Historical Processes	
Process Description	From 1944 to 1969, Building 8 was used to store fuel oil used by the rotary furnaces and other process machinery in Building 2. The fuel was pumped into Building 2 from storage tanks in Building 8 utilizing pumps located in Building 8A. (Note: From 1944 to 1958, Building 8 was located north of Building 2. In 1958, Building 8 was relocated to the east side of Building 2 in order to make way for Interstate 70 construction.) The storage tanks were removed and donated to the Missouri Department of Transportation in 1986.
Process Machinery	ASTs, piping, oil pumps, and oil heaters
Process Utilities	Electricity, water, foamite fire retardant, fuel oil, compressed air, and steam.
Hazardous Material Information	
Possible Hazardous Material Used	Fuel oil in Building 8. Fuel oil, ACM, LBP in Building 8A.
Hazardous Material Storage and Usage Areas	Fuel oil stored in nine 16,000- to 19,000-gallon ASTs and an oil drain sump used to temporarily store "dirty" return oil from Building 8A oil pumps
Hazardous Material Off-Loading Areas	From 1944 to 1958, oil was off-loaded from trucks into pipes in two loading pits located south of Building 8 at the top of the natural slope. The exact location of Building 8 from 1958 to 1969 is not known, but it was likely located east of Building 2.

Table 1-9. Summary of Physical Features for Buildings 9A through 9D

Building Characteristics				
Building Name	Acetylene Generation Area			
Area	Building 9:	1,228 ft²	Building 9A:	2,061 ft²
	Building 9B:	378 ft²	Building 9C:	Not applicable
	Building 9D:	455 ft²		
Style	Building 9:	Single story	Building 9A:	Single story
	Building 9B:	Sludge pit	Building 9C:	AST
	Building 9D:	Single story		
Construction Materials	Building 9:	Wooden frame, rafters, and roof; tile walls; and a concrete floor		
	Building 9A:	Concrete walls and floor, wooden rafters and decking		
	Building 9B:	Reinforced concrete		
	Building 9C:	Steel with reinforced concrete supports		
	Building 9D:	Concrete walls and floor, wooden rafters and roof decking		
Construction Date	Built in 1941 and modified in 1944. Acetylene Generator Building, Sludge Pits, and Oxygen Receiver removed in early 1980s.			
Historical Use				
Occupants/Lessees	1944 to 1983: SLAAP (105-mm Howitzer shell production)			
Operational Periods	1941 to 1944: Smokeless powder storage and canning 1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production			
Historical Processes				
Process Description	The Acetylene Generation Area supported acetylene production for SLAAP. Acetylene was generated by mixing calcium carbide and water. The reaction was contained in four acetylene generators in Building 9. Acetylene was then distributed through underground piping to Buildings 2 and 3. The byproduct of this reaction, calcium hydroxide slurry, was stored in two sludge pits located in Building 9 until it was transported off site.			
Process Machinery	Acetylene generators, pumps, a cold oxygen converter, and piping.			
Process Utilities	Acetylene, water, compressed air, and electricity.			
Hazardous Material Information				
Possible Hazardous Material Used	Smokeless powder, calcium carbide, machining cooling oil, sludges, ACM, and LBP			
Hazardous Material Storage and Usage Areas	Building 9:	Smokeless powder drip pots under acetylene generators		
	Building 9A:	Storehouse for calcium carbide		
	Building 9B:	Sludge pits with a sewer outfall		
	Building 9C:	AST for oxygen		
	Building 9D:	Cold oxygen converter		
Hazardous Material Off-Loading Areas	Sludges were pumped into trucks through a piping system installed on the north side of the Sludge Pits. The Sludge Pits were connected to the sewer system by underground piping.			

Table 1-10. Summary of Physical Features for Building 10

Building Characteristics			
Building Name	Quench Oil Storage Tanks		
Area	Building 10 consisted of three cylindrical, steel USTs and one rectangular, concrete UST. These tanks were located at the east outside end of Building 3 and were aligned in a north-south direction. The area covered by the USTs is approximately 30 by 100 feet. The tanks had the following dimensions:		
	Tank No.	Dimensions	Capacity (gallons)
	87	10 feet by 24 feet	14,100
	17	10.5 feet by 23.5 feet	15,222
	15	10.5 feet by 23.75 feet	15,332
	Sludge pit	11 feet (W) x 18 feet (L) x 13 feet (D)	17,000
Style	The USTs were horizontal steel tanks, each lying on three 18-inch-high saddles resting on a reinforced, 12-inch-thick, concrete foundation. A 7/8-inch-diameter rod with a turnbuckle was installed on each saddle for fastening the tank to the concrete foundation. The quench oil sludge pit was a reinforced concrete structure.		
Construction Materials	Steel and concrete (see above)		
Construction Date	1944		
Historical Use			
Occupants/Lessees	1941 to 1944:	SLOP	
	1944 to 1983:	SLAAP	
	1985 to 1996:	AVSCOM	
Operational Periods	1944 to 1945:	105-mm Howitzer shell production	
	1952 to 1954:	105-mm Howitzer shell production	
	1966 to 1969:	105-mm Howitzer shell production	
	1993:	UST removal activities were initiated in Jan 93.	
Historical Processes			
Process Description	The three quench oil USTs and the sludge pit supplied cooling oil (No. 6 fuel oil) to 14 quench oil tanks on the first floor of the east section of Building 3.		
Process Machinery	Quench oil USTs and a sludge pit.		
Process Utilities	Electricity, lubricating oils, compressed air, steam, and water.		
Hazardous Material Information			
Possible Hazardous Material Used	*Quench oil, hydraulic oil, solvents (toluene), and heavy metals*		
Hazardous Material Storage and Usage Areas	Underground:	The quench oil USTs were connected to 4" supply and return lines from the quench oil pumping room in Building 3. Spills drained to the quench oil sludge pit through a 6"gravity line. A second 6" gravity line was connected to the 14 indoor quench oil tank drain lines. The sludge pit clear oil return pumping system is located next to the middle section of the east basement wall of Building 3.	
	First Floor:	Transfer pumps and tanks stored quench oil.	
	Second Floor:	14 hardening furnaces used quench oil as cooling media.	
	Roof:	14 evaporative cooling systems cooled quench oil before it was returned to the quench oil system.	
Hazardous Material Off-Loading Areas	The quench oil USTs were filled using fill ports on top of the tanks. The quench oil system had a remote 4" fill line capability from railroad tracks on the northeast side of Building 3.		

Table 1-11. Summary of Physical Features for Buildings 11, 11A, and 11B

Building Characteristics	
Building Name	Foamite Generator Building (Bldg. 11) and Hose Cart Shelters (A and B)
Area	Original building covered 274 ft²; current building has approximately same dimensions and incorporates one of the hose cart shelters. Buildings 11A and 11B are each approximately 98 ft².
Style	Each of the buildings is one story.
Construction Materials	The original Building 11 had concrete block walls resting on a reinforced concrete foundation (including a 2- by 3-foot concrete drain pit) and a wooden roof. The building had a glass window with a steel frame and hinged top sections to allow air ventilation. The existing building is similar to the original one except that the building also houses the foamite hose cart shelter. Each of the hose cart shelters consist of concrete block walls resting on reinforced concrete foundation walls, a wooden roof, and a reinforced concrete floor.
Construction Date	Each of the buildings was constructed in 1944. The current building was built in late 1957 and early 1958.
Historical Use	
Occupants/Lessees	1941 to 1958: SLAAP 1958 to 1983: SLAAP 1985 to 1996: AVSCOM
Operational Periods	1944 to 1945*: 105-mm Howitzer shell production 1952 to 1954*: 105-mm Howitzer shell production 1958: Building was demolished during the relocation of Building 8; a new Building 11 constructed west of Building 2 across the roadway 1966 to 1969*: 105-mm Howitzer shell production *May have been operational for fire prevention during shut-down periods
Historical Processes	
Process Description	Generation of foamite involved the addition of dry foamite powder to pressurized water through an education system. The original system included a 15-horsepower pump system, a foamite generator, and a 4" foamite line that left the south corner of Building 11 and split into two main lines. The first line ran parallel to the northeast side of Building 2, and included two hydrants located south and west of Building 8A. The second line ran along the outer northwest and northeast banks of the earthen dike. This line contained two hydrants, one north of oil tank 24 and one east of oil tank 20. Additionally, independent lines (3") were connected to each oil tank to address localized oil tank fires.
Process Machinery	Foamite generator, a 15-horsepower motor and pump with switch disconnect, foamite distribution line, flexible hoses, and hose carts.
Process Utilities	Water, the foamite line, steam, electricity, and a sewer drain.
Hazardous Material Information	
Possible Hazardous Material Used	None
Hazardous Material Storage and Usage Areas	None
Hazardous Material Off-Loading Areas	None

Table 1-12. Summary of Comprehensive Environmental Baseline Survey Results

Location	Areas of Environmental Concern	Recommendations
Sitewide	ACM	Manage ACM in accordance with Asbestos Hazard Emergency Response Act (AHERA) regulations or requirements
	LBP	Complete LBP assessments and handle accordingly
	Fluorescent light ballast potentially containing PCBs	Remove and dispose of ballasts
Building 1	PCB oil-containing electrical equipment	Remove equipment
	PCB oil stain	Decontaminate stained area
	Metal-contaminated soil in east storage area and near sewer connections	Assess extent of metal contamination and evaluate remediation alternatives
Building 2	Metal-contaminated surface soil	Characterize and remove soil
	Metal-contaminated sump water	Characterize and remove water
	Chlorinated solvents-contaminated groundwater	Extent of contamination was assessed through interpretation of results from groundwater monitoring wells and no further characterization appears warranted
	Potential PCB contamination at former hydraulic oil storage tank area	Evaluate if additional characterization is warranted
Building 3	PCB-contaminated concrete floor in basement	Evaluate and implement appropriate remediation
	PCB-contaminated soil at basement earthen soil	Characterize and remove
	PCB-contaminated concrete and brick walls in basement and first-floor chip chute areas	Evaluate and implement appropriate remediation
	Various equipment in basement	Characterize and remove materials and equipment
	Airborne pesticides detected in basement	Evaluate and implement appropriate remediation
	Cracked and peeling paint and cracked concrete floor	Evaluate in conjunction with future use of property
	Semivolatile organic compound (SVOC) and PCB-contaminated soil underneath north loading dock	Assess and remediate soil
	PCB-contaminated drain and sump water	Characterize and remove water
	PCB-contaminated elevator equipment and oil stains in penthouses	Decontaminate or remove equipment or stains
Building 4	PCB oil-containing electrical equipment	Remove equipment
	PCB oil stain under electrical equipment	Decontaminate stained area
	PCB oil-stained transformer pad	Decontaminate stained area
	PCB-contaminated material in air compressor pits	Characterize and remove material
	SVOC-contaminated soil	SVOC contamination appears to be background condition and no further characterization appears warranted

Location	Areas of Environmental Concern	Recommendations
Building 5	PCB-contaminated elevator equipment and oil stains in penthouse	Decontaminate or remove equipment and stains
	SVOC-contaminated soil	SVOC contamination may be associated with former SLOP oil storage building
Building 6	Metal-contaminated ash in hearth	Characterize and remove ash
	SVOC-contaminated soil	SVOC contamination may be associated with former SLOP oil storage building
Building 7	No areas of environmental concern	No further characterization appears warranted
Building 8 and 8A	SVOC contaminated soil with extent assessed	Extent of SVOC contamination assessed and no further characterization appears warranted
Buildings 9 and 9a through 9D	No areas of concern	No further characterization appears warranted
Building 10	Leaking UST incident extent assessed	No further characterization appears warranted; MDNR to provide guidance to close UST
Building 11, 11A, and 11B	No areas of concern	No further characterization appears warranted

Table 3-1. Identification of Inputs to the Decision

Location	Area of Environmental Concern	Sampling Method(s) and Rationale
Site-Wide	Asbestos Containing Material	No site-wide sampling of ACM is proposed. The presence of ACM throughout the site is documented in the Comprehensive EBS. Approaches to removal of ACM are well understood and readily available. These materials will be handled, as necessary, in accordance with Asbestos Hazard Emergency Response Act (AHERA) regulations.
	Lead-Based Paint	No site-wide sampling of LBP is proposed. Process knowledge and construction techniques suggest that LBP is present within and around each of the buildings at the site. Approaches to removal of LBP are well understood and readily available. These materials will be handled, as necessary, in accordance with appropriate regulations.
	Fluorescent light ballast potentially containing PCBs	No site-wide sampling is proposed. Light ballasts can be removed, as appropriate, and handled in a compliant manner without collection of additional data during this effort.
	Sewer system. The EBS report identifies concerns at several buildings with regard to potential releases to the sewer system. Given these concerns, and the site-wide existence of said system, the sewers have been added as a site-wide category.	Video surveys of the sewer system will be conducted throughout selected sewer mains as indicated on **Figure 3-10**. Sediment and wastewater samples will be collected from sewer mains via manholes (see **Figure 10** for sample locations). Contingency borings will be installed and sampled to delineate the lateral extent of contamination in the event breaches in the sewers are identified during the video survey and associated sediment/wastewater samples exceed threshold values for total metals (23), VOCs, SVOCs, PCBs, and/or TPH.
	Groundwater	Groundwater across the site consists of localized perched units that are at least 12 feet below ground surface. Detections to date have been low-level. Given the industrial setting of the site and the lack of a completed pathway, i.e., no receptors, additional groundwater characterization is not required. Consequently, no additional monitoring wells are planned as part of this effort.
Building 1	PCB oil-containing electrical equipment	No sampling of the equipment for PCBs is proposed. Samples can be collected, if required, during equipment removal, as appropriate.
	PCB oil stain	A soil boring will be installed at the stain location as shown in **Figure 3-1**. Samples will be collected from the concrete (01CS-01) and from the soils beneath the concrete floor (01SB-07). Additionally, process knowledge suggests that releases could have occurred from the breaking operations and/or leaking transformers. The integrity of the concrete floor and sump structures is unknown. Accordingly, soil borings will be advanced at two breaking locations (see **Figure 3-1**, 01SB-01 and 01SB-02) to evaluate whether or not PCB/TPH contamination exists beneath the building floor. Contingency borings will be completed if target thresholds are exceeded, to delineate the lateral extent of contamination.
	Metal-contaminated soil in east storage area and near sewer connections	Process knowledge suggests that releases containing heavy metals could have occurred to soils and the sumps/sewer system as a result of billet storage. As shown in **Figure 3-1**, soil borings will be sampled at each of the sump locations (near the cold saw cut operations and near the grinding operations, 01SB-08 through 01SB-11). Contingency borings will be completed if target thresholds are exceeded. Evaluation of the sewer system will be conducted as part of the site-wide sewer study (see site-wide section above). Soil borings will also be completed along the eastern and western sides of the building (01SB-03 through 01SB-06) and in the east and west parking lot (see **Figure 3-2**, locations 01SB-12 through 01SB-17). Contingency borings will be completed if target thresholds are exceeded, to delineate the lateral extent of contamination.

Note: All sampling and surveying activities will be completed in accordance with protocols presented in Section 4 of this FSP.

Location	Area of Environmental Concern	Sampling Method(s) and Rationale
Building 2	Metal-contaminated surface soil Metal-contaminated sump water Chlorinated solvents-contaminated groundwater Potential PCB contamination at former hydraulic oil storage tank area TPH within and under the fuel lines/vaults (regulatory concern mentioned during finalization of the Comprehensive EBS)	Process knowledge suggests that the rotary furnaces, quenching operations, maintenance area, and/or fuel delivery systems may have been responsible for environmental impacts throughout the building footprint. Building-wide contamination includes TAL/TCL metals, VOCs, PCBs, and/or TPH in surface soils, subsurface soils, and/or groundwater. Accordingly, rather than present sampling activities that directly correlate to specific areas of concern from the Comprehensive EBS, the sampling strategy for Building 2 is presented from a building-wide perspective. Investigations planned for Building 2 (see **Figure 3-3** for sample locations) are as follows: • Quench tanks within Building 2 overflowed on a regular basis to a series of north/south trending floor drains along the eastern and western perimeter of the building. These drains are believed to connect into sewer lines along the interior of the western and southern sides of Building 2. Sediment and water samples will be collected from each of the interior manholes (**Figure 3-3**, 02SD-01 through 02SD-03 and 02WW-01 through 02WW-03, respectively) in accordance with protocols presented in Section 4 of this FSP. Evaluation of the sewer system (i.e., those portions of the sewer drain system outside of the building's footprint will be conducted as part of the site-wide sewer study). • The foundation rings for each of the rotary furnaces and accompanying "production loop" (i.e., process area including descaling station, piercing operations, draw bench area, etc.) are potential collection areas for hydraulic oil, lubricants, and/or fuel. The structural integrity of these structures is unknown. Accordingly, two of the "production loops" will be excavated to determine the likelihood and degree of contamination present within and/or from these units. Sample locations (see **Figure 3-3**) 02TX-01 through 02TX-04 delineate samples to be collected from the first production loop. Sample locations 02TX-05 through 02TX-08 delineate samples to be collected from the second production loop. Suspicious sediments or residues within the structures will be sampled, if encountered. A ram-hoe attachment or equivalent equipment will be utilized to break through the concrete to allow sampling of the underlying material. Soil samples will be collected from the excavation at each of the "production loop stations". Contingency soil borings will be completed if target thresholds are exceeded. A total of 20 refractory bricks (2 from each of the 10 foundation rings) will be collected from the foundation rings for asbestos analysis (to ascertain waste disposal requirements for the bricks). Refractory brick sample locations are shown in **Figure 3-3** by sample locations 02AC-01 through 02AC-20. • Oil stains are present in various locations within the building. Surface and subsurface soil samples will be collected for PCB and TPH analysis at locations 02SB-01 through 02SB-04. Contingency samples will be collected to define lateral/vertical extent, if appropriate, pending evaluation of the initial results, to delineate the lateral extent of contamination. • An east-west trending pipe trench exists within Building 2 that served as a redundant feed system between large pumps in the building. Additionally, two large above-ground storage tanks (one on each side of the building) stored hydraulic oil that was ultimately delivered to the production loops. Soil borings will be installed along the redundant feed system and at each of the above-ground storage tank locations as indicated in **Figure 3-3** (02SB-05 through 02SB-09). Samples collected from each of the borings will be analyzed for PCBs. • Sediment samples will be collected from the fuel distribution vaults for TPH analysis. Sediment sample locations are shown on **Figure 3-3** as 08SD-01 and 08SD-02.
Building 3	PCBs in the following areas • concrete floor in basement • basement earthen soil • concrete and brick walls in basement and first-floor chip chute areas • various equipment • drain and sump water • elevator equipment and stains in penthouses Cracked and peeling paint and cracked concrete floor	PCB contamination associated with Building 3 is being characterized and remediated under a separate effort. No additional sampling for PCBs will be conducted as part of this effort. Lead-based paint is addressed as a site-wide issue above.

Note: All sampling and surveying activities will be completed in accordance with protocols presented in Section 4 of this FSP.

Location	Area of Environmental Concern	Sampling Method(s) and Rationale
Building 3 (continued)	Semi-volatile organic compound (SVOC) and PCB-contaminated soil near the chip chute area on the north side of the building	PCB-contaminated soil in excess of 50 ppm is suspected to be present outside (north) of the former chip chute area. AMCOM plans to excavate and dispose of this contamination in the near future. The limits of excavation associated with this effort will be determined within the upcoming weeks. Upon determination of the excavation limits, the need for additional borings to determine the lateral and vertical extent of any remaining contamination will be evaluated. The actual location of any required borings cannot be determined until excavation limits are defined, but **Figure 3-4** shows potential boring locations which may be installed to define the lateral and vertical extent of contamination both within and around the remediated region. Additional contingency borings will be installed, if appropriate, pending results of the new borings, to delineate the lateral extent of contamination.
	Airborne pesticides in earthen soil detected in basement	Process knowledge suggests that rodent/insect controls may have been utilized in the basement. Furthermore, soils samples collected in an earlier study and an air sample collected during the EBS confirmed the presence of pesticides in the basement. Consequently, soil samples collected in support of the risk assessment will be analyzed for pesticides.
Building 4	PCB oil-containing electrical equipment	No sampling of the equipment for PCBs is proposed. Samples can be collected, if required, during equipment removal, as appropriate.
	PCB oil stain under electrical equipment	PCBs have been detected in oil stains on the concrete floor. Consequently, samples will be collected from the concrete and the underlying soils to determine the extent of the contamination (see **Figure 3-5**, 04CS-01 and 04SB-01). Contingency borings will be installed, if necessary, to delineate the lateral extent of contamination.
	PCB oil-stained transformer pads	Wipe samples will be collected in the basement beneath two large transformer bases (one external [04SW-01] and one internal [04SW-02] to the original building footprint as shown in **Figure 3-5**) and analyzed for PCBs. If PCBs are detected in excess of the PCB Rule [40 CFR 761], samples will be collected from the concrete and the underlying soils to evaluate the extent of the contamination. Contingency borings will be installed, if necessary, to delineate the lateral extent of contamination.
	PCB-contaminated material in air compressor pits	Process knowledge suggests that releases could have occurred from leaking compressors. The integrity of the concrete floor and pit structures is unknown. Accordingly, soil borings will be advanced at two locations (04SB-02 and 04SB-03) to determine whether or not PCB/TPH contamination exists within the concrete and/or beneath the building floor. Contingency borings will be completed if target thresholds are exceeded. Sample locations are shown on **Figure 3-5**.
	SVOC-contaminated soil	The Comprehensive EBS Report states that SVOC contamination is likely a background condition and no further characterization is warranted.
Building 5	PCB-contaminated elevator equipment and oil stains in penthouse	PCBs have been detected in oil staining near the elevator equipment in the penthouse. Oil staining has also been visually observed in the elevator shaft. Consequently, a wipe sample (05SW-01) will be collected from stained area within the elevator shaft. Samples of the concrete and the underlying soils will be collected if the wipe sample indicates that PCBs are present. Contingency borings will be installed, if necessary, to delineate the lateral extent of contamination. Sample locations are shown on **Figure 3-6**.
	SVOC-contaminated soil	One soil boring (05SB-01) will be installed at the former oil storage area and sampled for SVOC and TPH. Contingency borings will be installed, if necessary, to delineate the vertical extent of contamination. Sample locations are shown on **Figure 3-6**.
Building 6	Metal-contaminated ash in hearth	The detection of metal contamination in the hearth ash created a concern with regard to the old ventilation system. In an earlier building configuration, the dark room and laboratory were adjacent to the hearth room and were all likely tied into the same ventilation ducting. Renovation activities would have generally eliminated any contaminants that may have been present. However, to address the concern with regard to the old ventilation system, a wipe sample (06SW-01) and a sediment sample (06SD-01) will be collected from the ventilation ducting in the hearth room and analyzed for metals, VOCs, and SVOCs. Sample locations are shown on **Figure 3-7**.
	SVOC-contaminated soil	One soil boring (06SB-01) will be installed at the former oil storage area and sampled for SVOC and TPH. Contingency borings will be installed, if necessary, to delineate the vertical extent of contamination. Sample locations are shown on **Figure 3-7**.

Note: All sampling and surveying activities will be completed in accordance with protocols presented in Section 4 of this FSP.

Location	Area of Environmental Concern	Sampling Method(s) and Rationale
Building 7	EBS identified no areas of environmental concern, however, concrete staining in the building and hexavalent chromium from the cooling tower operations will be addressed as part of this FSP.	TPH is suspected in stains on the building floor. Consequently, a wipe sample (07SW-01) will be collected from the stained area and analyzed for TPH. Samples of the concrete and the underlying soils will be collected if the wipe sample indicates that TPH is present. Contingency borings will be installed, if necessary, to delineate the lateral extent of contamination. Sample locations are shown on **Figure 3-8**. Process knowledge suggests that sediments from the cooling tower operation may contain hexavalent chromium. Consequently, a test pit (07TX-01) will be excavated within the former cooling tower base to identify whether the sediment layer exists. A soil sample will be collected from the sediment layer and analyzed for hexavalent chromium. If the analytical results exceed threshold values, a trench will be excavated laterally from the test pit to establish the radial extent of contamination. Samples will be collected at 10 foot intervals at discrete depth locations from within the trench. Sample locations are shown on **Figure 3-8**.
Building 8 and 8A	SVOC-contaminated soil with extent assessed. Regulatory comments on the EBS Report requested additional characterization of the fuel lines leading to Building 2.	Extent of SVOC contamination has been assessed as part of the Comprehensive EBS and no further characterization appears warranted. As noted in the Building 2 description above, sediment samples (08SD-01 and 08SD-02) will be collected from within the fuel distribution vaults for TPH analysis. Contingency borings will be installed, if necessary, to delineate the lateral extent of contamination. Additionally, soil borings (08SB-01 through 08SB-07 will be installed along the fuel distribution pipeline connecting Buildings 2 and 8. Sample locations are shown on **Figure 3-3**.
Buildings 9 and 9A through 9D	No areas of concern	No further characterization appears warranted.
Building 10	Leaking UST incident extent assessed	Soil borings (10SB-02 through 10SB-05) will be installed at locations outside of the original excavation to determine the levels of residual contamination associated with the USTs. Additionally, to determine the vertical extent of any residual contamination, one soil boring (10SB-01) will be advanced at the location of the former USTs and sampled beneath the buried concrete pad that supported the USTs. Soil samples will be analyzed for TPH and BTEX. Potential sample locations are shown on **Figure 3-9**, but since the extent of the previous excavation is visually evident, the actual sample locations just beyond the excavation will be selected in the field. Additional contingency borings will be installed, if appropriate, pending results of the new borings, to delineate the lateral extent of any residual contamination.
Building 11, 11A, and 11B	No areas of concern	No further characterization appears warranted.

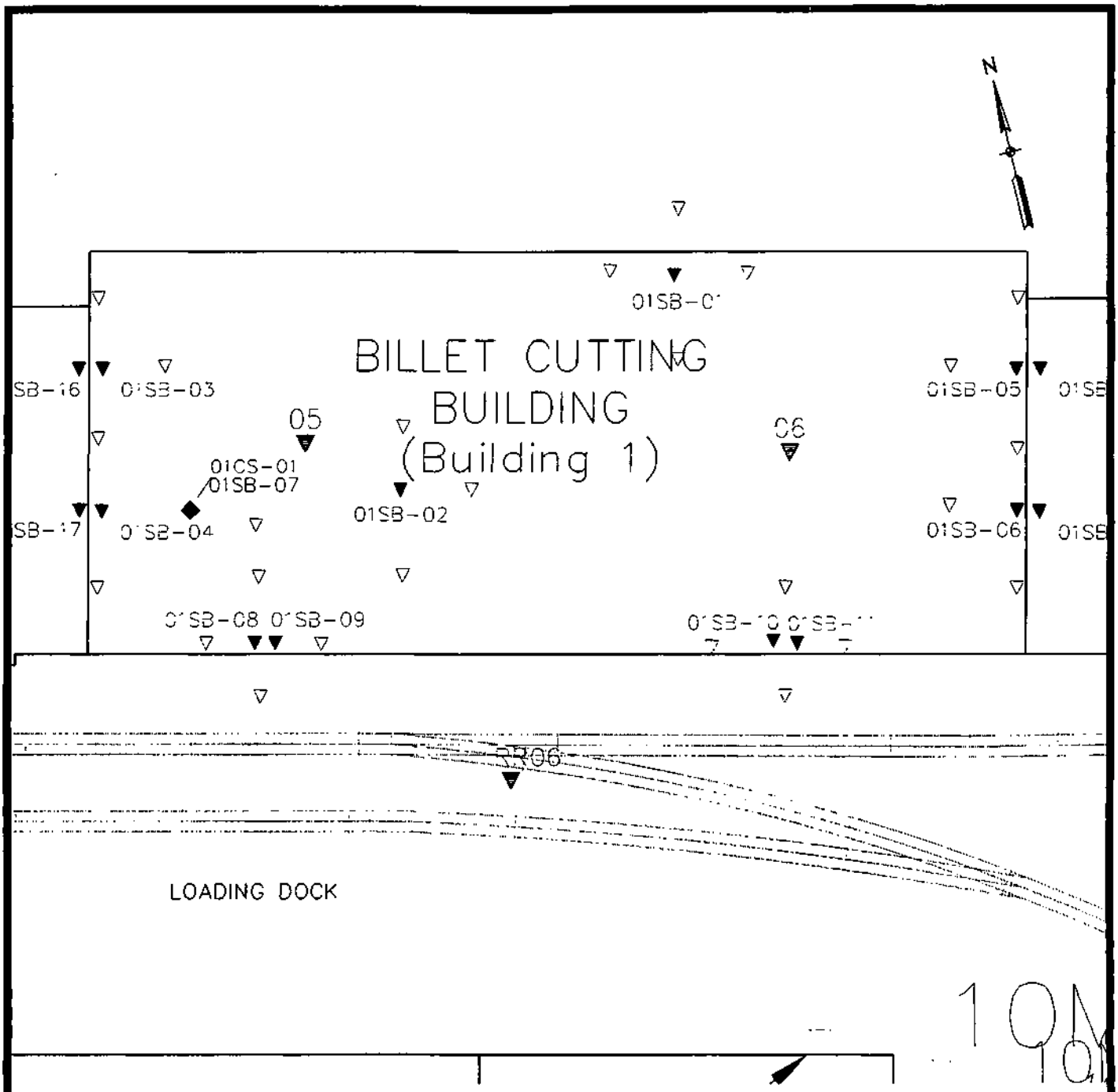
Note: All sampling and surveying activities will be completed in accordance with protocols presented in Section 4 of this FSP.

Table 3-2. Summary of Sample Collection Activities

Area of Concern/ Figure Numbers	Phase	Wipe	Concrete	Soil Boring	Test Pit	Sediment	Wastewater	ACM
Site-Wide	Primary					11	11	
Figure 3-10	Contingency							
Figure 3-11	Risk			33				
Building 1	Primary		1	17				
Figures 3-1 and 3-2	Contingency			31				
Figure 3-11	Risk			10				
Building 2	Primary			9	8	2	2	20
Figure 3-3	Contingency			56				
Figure 3-11	Risk			12				
Building 3	Primary							
Figure 3-4	Contingency			9				
Figure 3-11	Risk			18				
Building 4	Primary	2	1	3				
Figure 3-5	Contingency		2	9				
Figure 3-11	Risk			10				
Building 5	Primary	1		1				
Figure 3-6	Contingency		1	4				
Figure 3-11	Risk			16				
Building 6	Primary	5		1		1		
Figure 3-7	Contingency		4	8				
Figure 3-11	Risk			16				
Building 7	Primary	1			1			
Figure 3-8	Contingency		1	1	6			
Figure 3-11	Risk			16				
Building 8	Primary			7		2		
Figure 3-3	Contingency			29				
Figure 3-11	Risk			20				
Building 10	Primary			5				
Figure 3-9	Contingency			5				
Figure 3-11	Risk							
Totals	Primary	9	2	43	9	16	13	20
	Contingency	0	8	152	6	0	0	0
	Risk	0	0	151	0	0	0	0

Table 9-1. Required Field Instruments

Instrument	Intended Use
Water Quality Monitor	Collection of water quality parameters for wastewater samples
PID	Detection of organic vapors in confined spaces
Multi-Gas Meter	Measurement of O_2 and explosive gasses in confined spaces
Dust Monitor	Quantification of dust levels during concrete cutting and coring operations



LEGEND:

▼01SB-04 SOIL BORING (▽= CONTINGENCY BORING)

◆04CS-01 CONCRETE SAMPLE & SOIL
04SB-01 BORING (◇ =CONTINGENCY SAMPLE AND BORING)

05
▼ RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-1**
PROPOSED SAMPLING LOCATIONS IN BUILDING 1

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 2:24:47 pm (MAD)
J:\F0K96219.01\LAYOUT-01.dwg

SWMW-7

Location of Fuel Oil Storage Area (Building 8) from 1958 to 1986

PAVED PARKING LOT

SWMW-6

BLDG.

BILLET CUTTING BUILDING (Building 1)

PAVED PARKING LOT (Former Storage Yard)

PAVED PARKING LOT (Former Storage Yard)

LOADING DOCK

10MW-1

GASOLINE DISPENSER (Removed)

GASOLINE UST (Removed)

QUENCH SLUDGE PIT (Removed)

BUILDING 10D

DRIOX OXYGEN CONVERTOR (Building 9D) (Removed)

MACHINING BUILDING (Building 3)

AST DRIOX OXYGEN RECEIVER (Building 9C)

CARBIDE STORAGE BUILDING (Building 9A) (Removed)

QUENCH OIL TANKS (Removed)

ADDITION D

SLUDGE PITS (Removed)

ACETYLENE GENERATOR BUILDING (Building 9) (Removed)

PAVED PARKING LOT

SWMW-5

LEGEND:

- ⊕SWMW-1 MONITORING WELL LOCATION
- ▼01SB-04 SOIL BORING (▽ = CONTINGENCY BORING)
- ▲04SW-02 SURFACE WIPE SAMPLE
- 05 ▼ RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)
- ◆04CS-01 / 04SB-01 CONCRETE SAMPLE & SOIL BORING (◇ =CONTINGENCY SAMPLE AND BORING)

N

100 0 100 200

SCALE FEET

URS Group Inc.
10975 El Monte, Suite 100
Overland Park, Kansas 66211

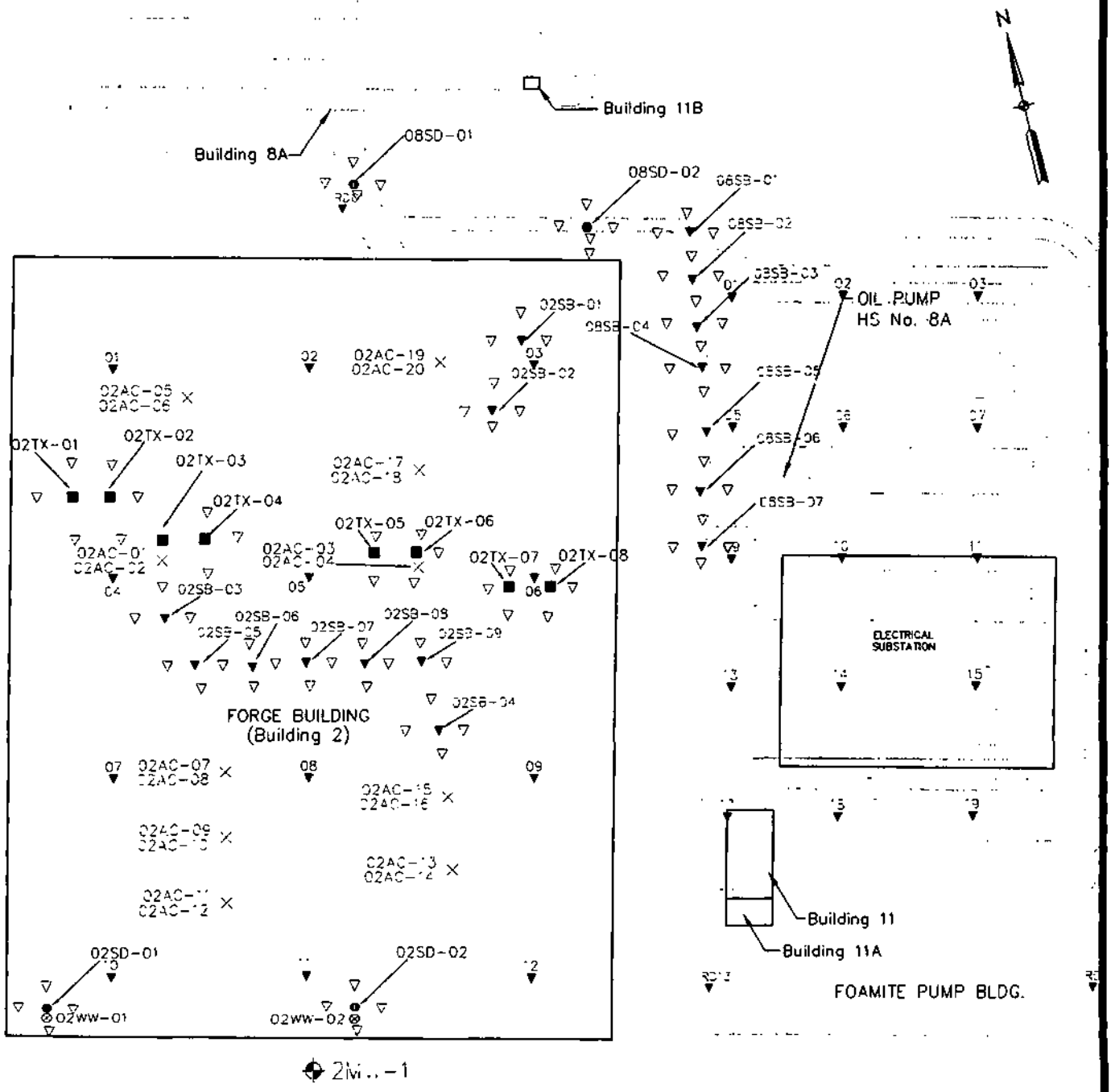
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-2**
PROPOSED SAMPLING LOCATIONS IN PARKING LOTS ADJACENT TO BUILDING 1

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 16, 2001 8:57:35 am (WXS)
J:\F0K96219.01\LAYOUT-01.dwg



60 0 60 120

SCALE FEET

LEGEND:

- ⊕SWMW-1 MONITORING WELL LOCATION
- ▼02SB-04 SOIL BORING (7 = CONTINGENCY BORING)
- ■07TX-01 TEST PIT (□ = CONTINGENCY BORING)
- ●08SD-01 SEDIMENT SAMPLE
- ⊗02WW-01 WASTEWATER SAMPLE
- ×02AC-02 ACM SAMPLE
- 05 ▼ RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

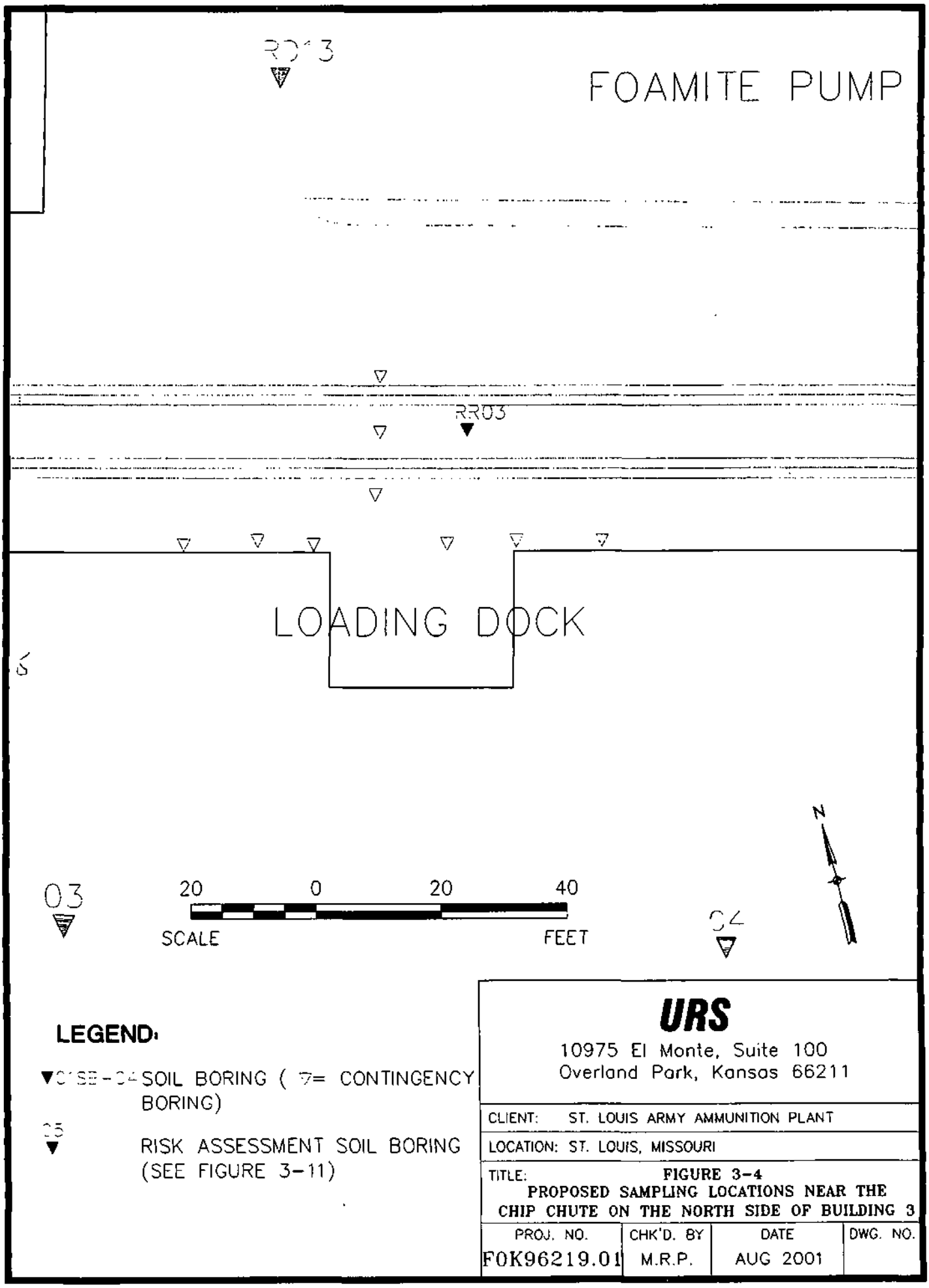
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-3**
PROPOSED SAMPLING LOCATIONS IN BUILDINGS 2, 8 AND 8A

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 16, 2001 9:33:28 am (WXS)
J:\(F0K96219.01\LAYOUT-01.dwg



LEGEND:

▼ SOIL BORING (= CONTINGENCY BORING)

▼ RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

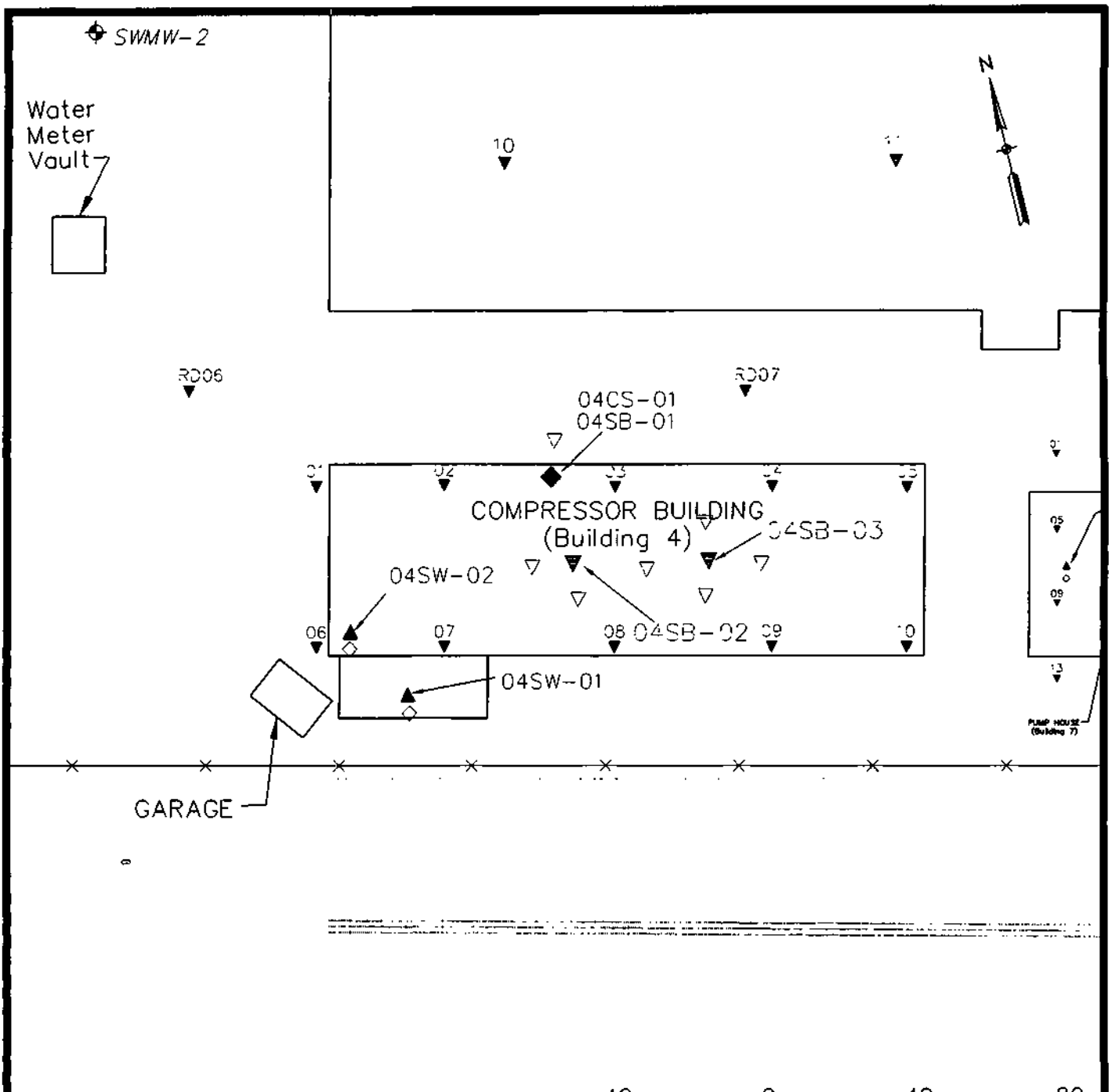
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-4**
PROPOSED SAMPLING LOCATIONS NEAR THE CHIP CHUTE ON THE NORTH SIDE OF BUILDING 3

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 12:47:24 pm (MAD)
J:\F0K96219.01\LAYOUT-01.dwg



LEGEND:

- SWMW-1 MONITORING WELL LOCATION
- 01SB-04 SOIL BORING (▽ = CONTINGENCY BORING)
- 04SW-02 SURFACE WIPE SAMPLE
- 04CS-01 / 04SB-01 CONCRETE SAMPLE & SOIL BORING (◇ = CONTINGENCY SAMPLE AND BORING)
- 05 RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

40 0 40 80

SCALE FEET

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

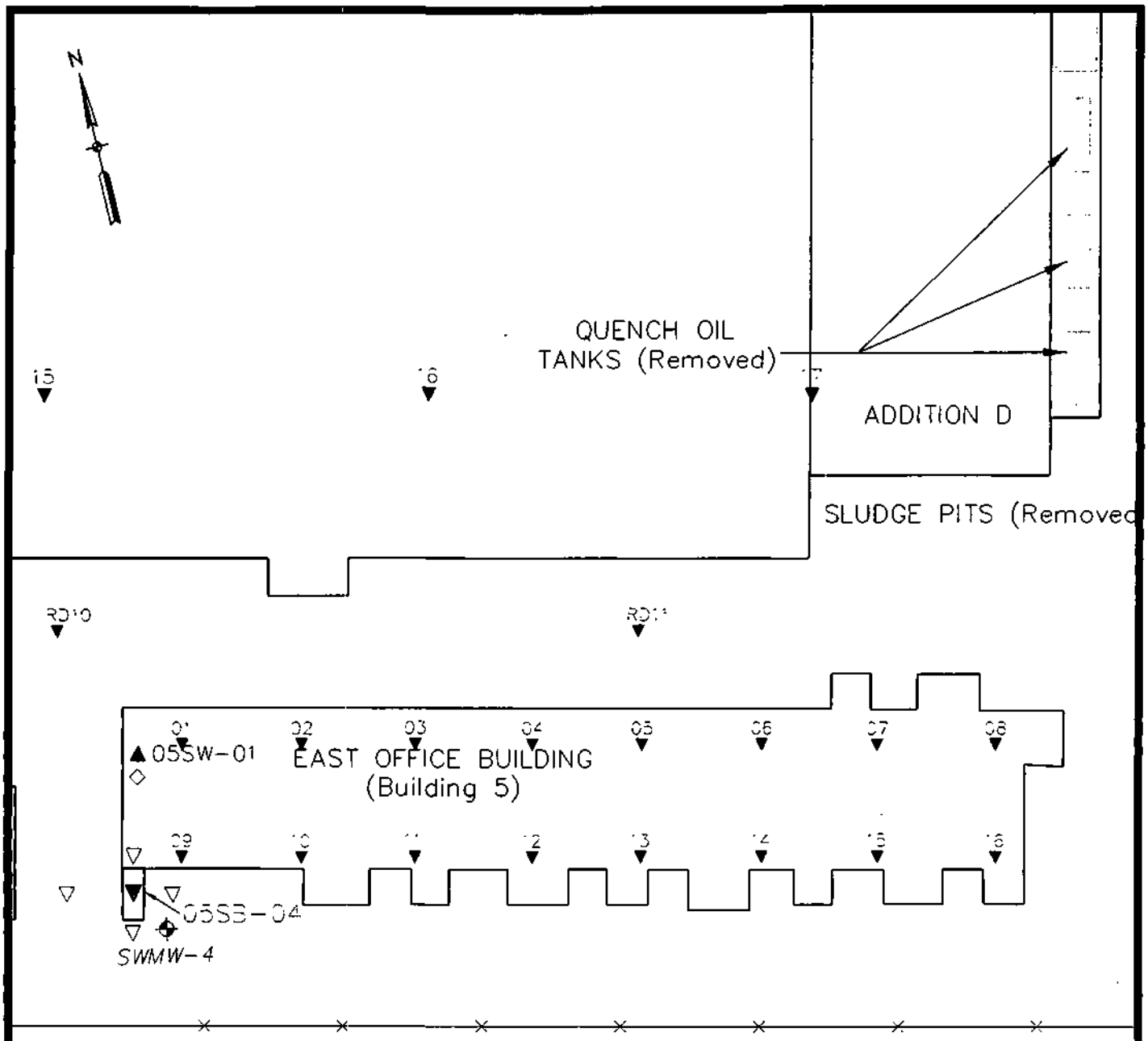
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-5**
PROPOSED SAMPLING LOCATIONS IN BUILDING 4

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 2:25:44 pm (MAD)
J:\F0K96219.01\LAYOUT-01.dwg



LEGEND:

- ⊕ SWMW-1 MONITORING WELL LOCATION
- ▼05SB-04 SOIL BORING (▽ = CONTINGENCY BORING)
- ▲04SW-02 SURFACE WIPE SAMPLE
- ◆04CS-01 04SB-01 CONCRETE SAMPLE & SOIL BORING (◇ =CONTINGENCY SAMPLE AND BORING)
- 05 ▼ RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

40 0 40 80

SCALE FEET

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

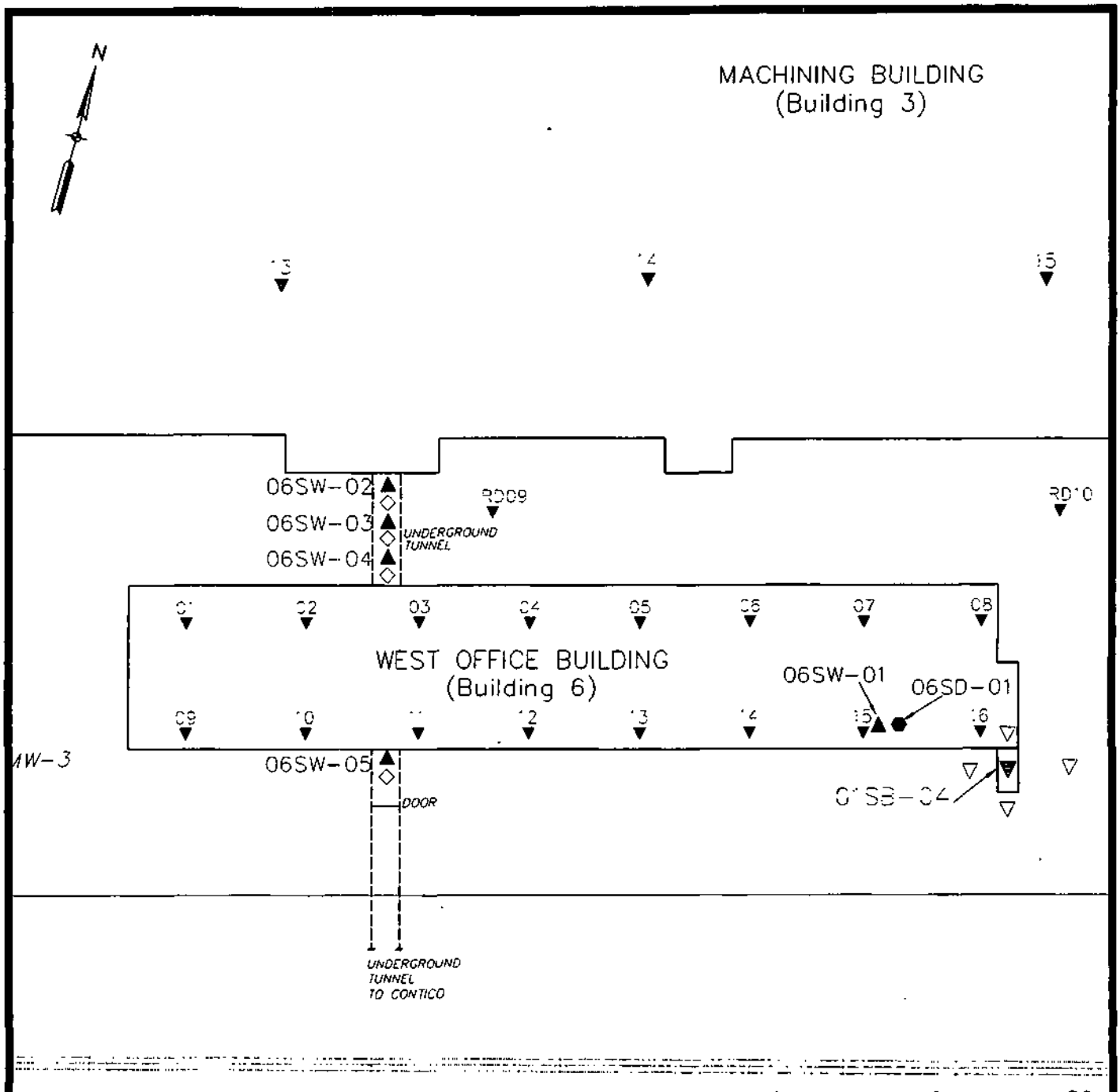
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-6**
PROPOSED SAMPLING LOCATIONS IN BUILDING 5

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 1:06:29 pm (MAD)
J:\F0K96219.01\LAYOUT-01.dwg



40 0 40 80

SCALE FEET

LEGEND:

- ▼06SB-04 SOIL BORING (▽ = CONTINGENCY BORING)
- ▲04SW-02 SURFACE WIPE SAMPLE
- ◆04CS-01 04SB-01 CONCRETE SAMPLE & SOIL BORING (◇ = CONTINGENCY SAMPLE AND BORING)
- ▼05 RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

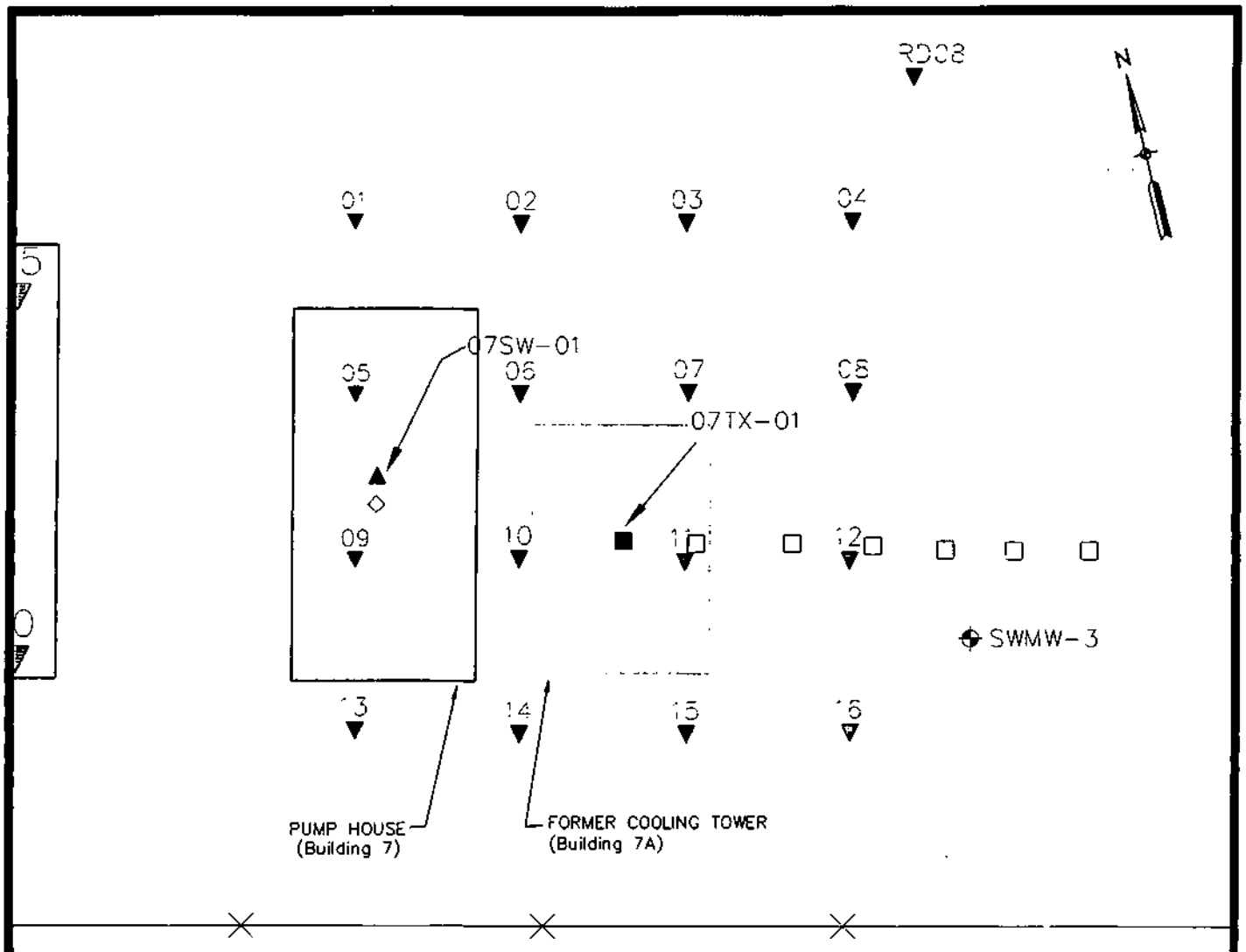
URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT:	ST. LOUIS ARMY AMMUNITION PLANT
LOCATION:	ST. LOUIS, MISSOURI
TITLE:	**FIGURE 3-7 PROPOSED SAMPLING LOCATIONS IN BUILDING 6**

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 1:04:53 pm (MAD)
J:\F0K96219.01\La\F0U1-01.dwg



LEGEND:

- ◆SWMW-1 MONITORING WELL LOCATION
- ■07TX-01 TEST PIT (□ = CONTINGENCY BORING)
- ▲04SW-02 SURFACE WIPE SAMPLE
- ◆04CS-01 CONCRETE SAMPLE & SOIL 04SB-01 BORING (◇ =CONTINGENCY SAMPLE AND BORING)
- 05 RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

20 0 20 40

SCALE FEET

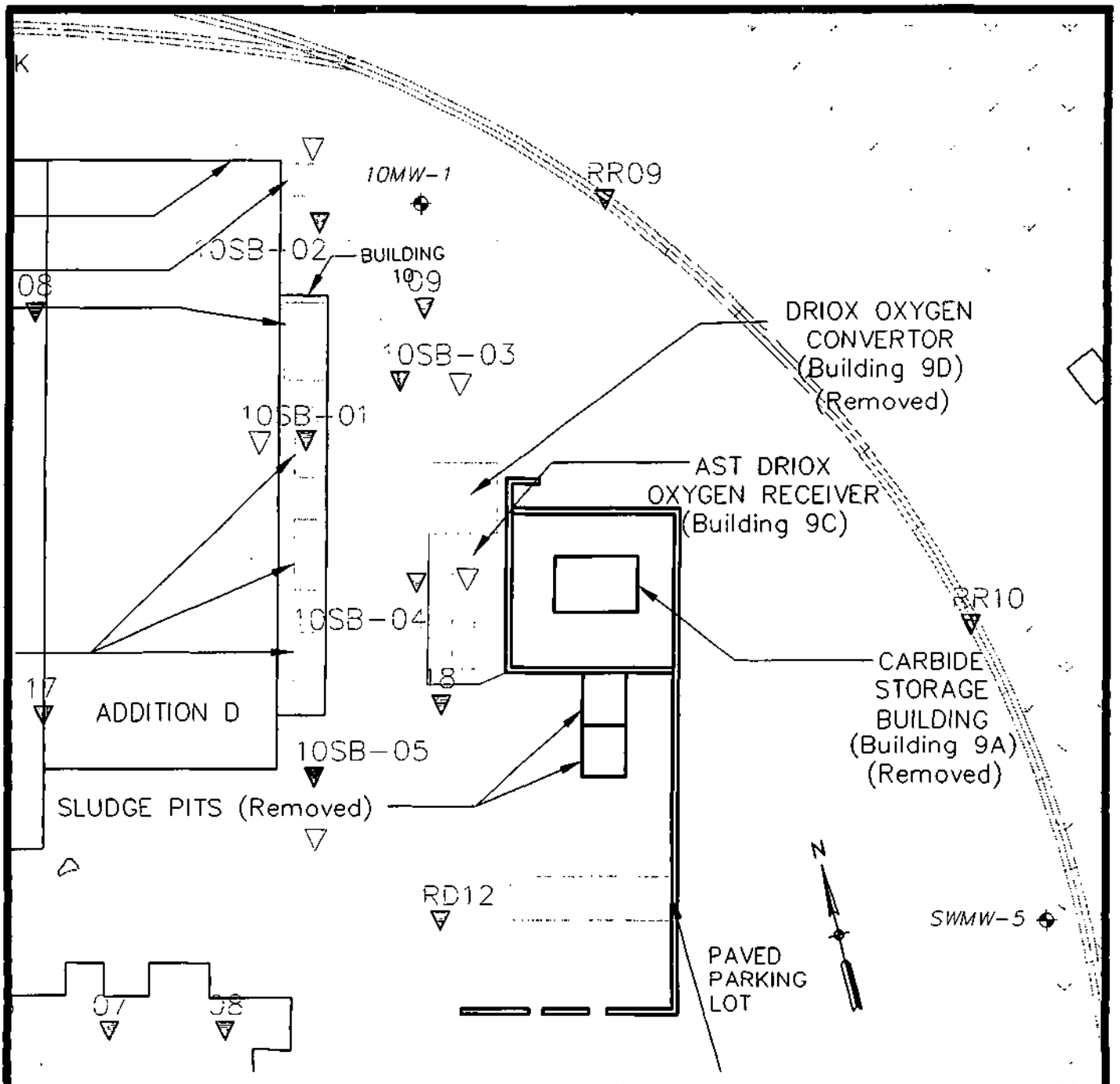
URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT:	ST. LOUIS ARMY AMMUNITION PLANT
LOCATION:	ST. LOUIS, MISSOURI
TITLE:	FIGURE 3-8 PROPOSED SAMPLING LOCATIONS IN BUILDING 7

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 1:02:23 pm (MAD)
J:\F0K96219.01\LAYOUT-01.dwg



LEGEND:

- ⊕SWMW-1 — MONITORING WELL LOCATION
- ▼ 10SB-0? — SOIL BORING (▽ = CONTINGENCY BORING)
- 05 ▼ — RISK ASSESSMENT SOIL BORING (SEE FIGURE 3-11)

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

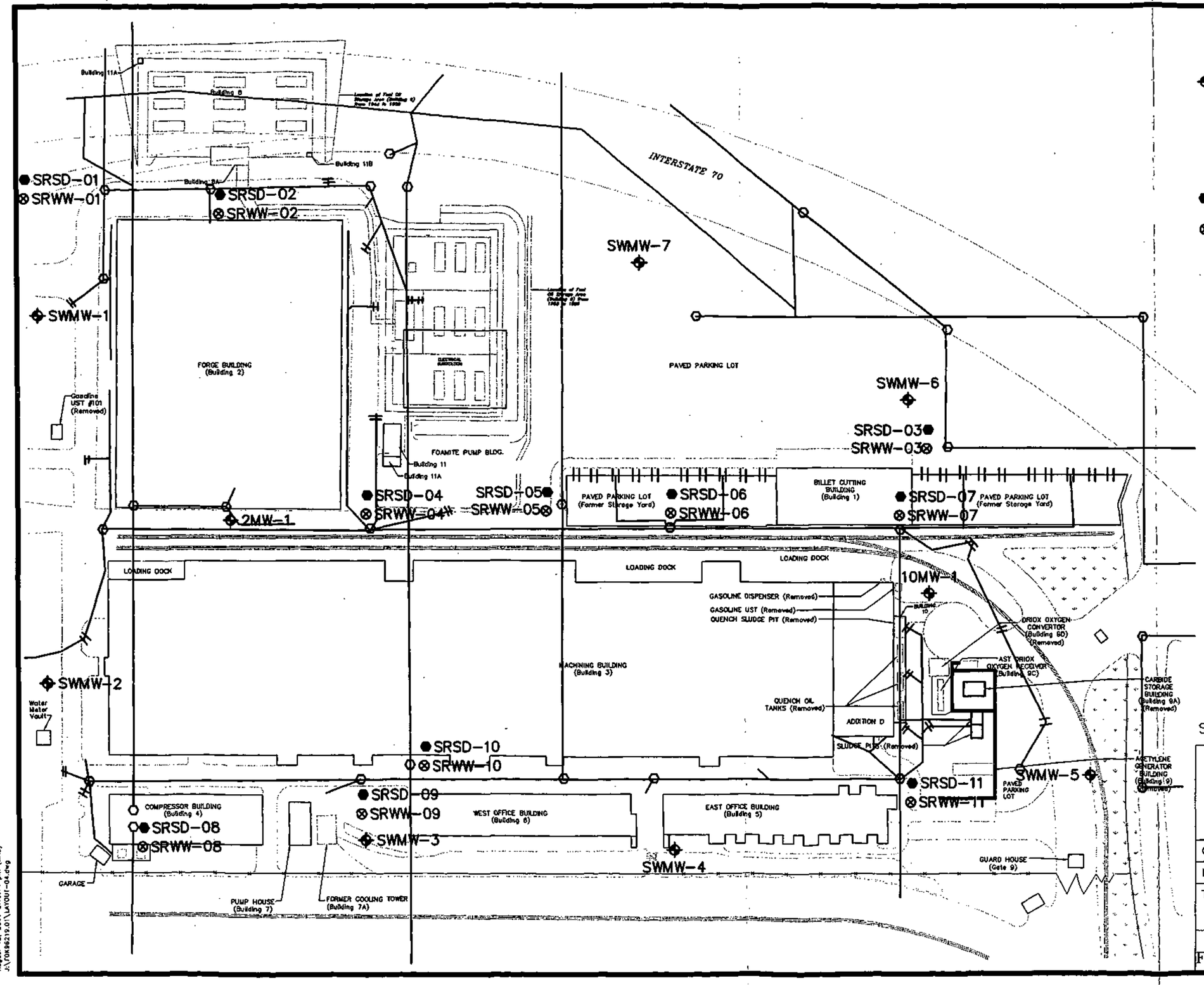
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: **FIGURE 3-9**
PROPOSED SAMPLING LOCATIONS NEAR BUILDING 10

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 16, 2001 9:53:01 am (WXS)
J:\F0K96219.01\LAYOUT-03.DWG



LEGEND:

- SWMW-1 MONITORING WELL LOCATION
- SEWER LINE
- MANHOLE
- CATCH BASIN/SEWER INLET
- SRSD-01 SEDIMENT SAMPLE
- SRWW-01 WASTEWATER SAMPLE

N

100 0 100 200

SCALE FEET

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

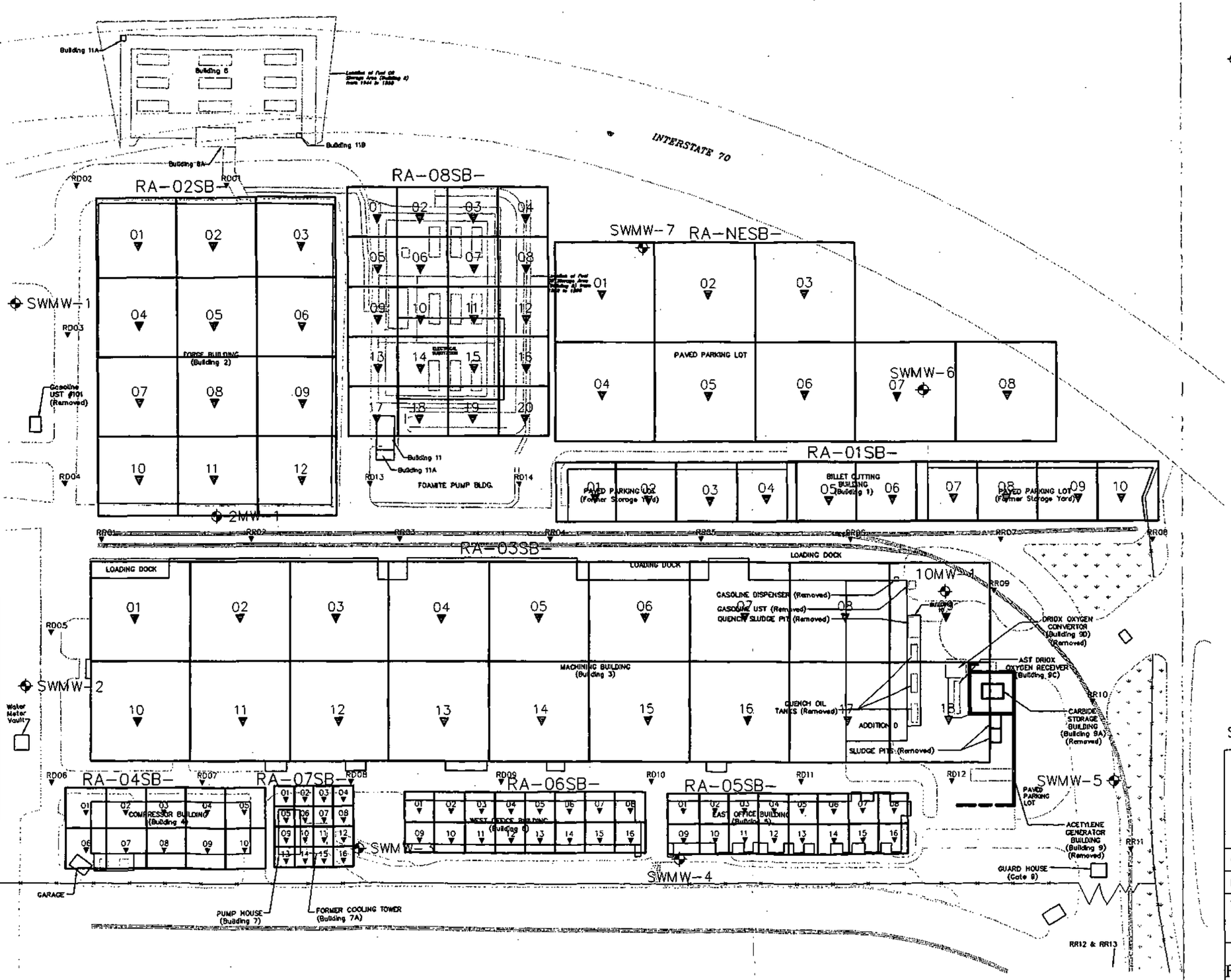
CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: FIGURE 3-10
PROPOSED SAMPLING LOCATIONS FOR THE SITE-WIDE SEWER SURVEY

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 2:18:14 pm (MAD)
J:\F0K96219.01\LAYOUT-04.dwg



LEGEND:

- SWMW-1 MONITORING WELL LOCATION
- 02 SOIL BORING

RA-07SB-

01	02	03	04
05	06	07	08
09	10	11	12
13	14	15	16

SYSTEMATIC SAMPLING GRID FOR SAMPLES RA-07SB-01 THROUGH RA-07SB-16

- RD02 RA-RDSB-02 SAMPLE LOCATION
- RR02 RA-RRSB-02 SAMPLE LOCATION

N

100 0 100 200

SCALE FEET

URS

10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT: ST. LOUIS ARMY AMMUNITION PLANT

LOCATION: ST. LOUIS, MISSOURI

TITLE: FIGURE 3-11
LOCATION OF SYSTEMATIC RISK ASSESSMENT SAMPLES

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
F0K96219.01	M.R.P.	AUG 2001	

August 15, 2001 2:46:03 pm (MAD)
J:\F0K96219.01\LAYOUT-03.DWG

FIGURE 5-1

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-01(00-01)-1101DQ
Site: BLDG 1
Location: SB-01
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-01(00-01)-1101DQ
Site: BLDG 1
Location: SB-01
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-01(00-01)-1101DQ
Site: BLDG 1
Location: SB-01
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
PCB
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-01(00-01)-1101DQ
Site: BLDG 1
Location: SB-01
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
PCB
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-02(09-10)-1101DQ
Site: BLDG 1
Location: SB-02
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-02(09-10)-1101DQ
Site: BLDG 1
Location: SB-02
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-02(09-10)-1101DQ
Site: BLDG 1
Location: SB-02
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
PCB
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-02(09-10)-1101DQ
Site: BLDG 1
Location: SB-02
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
PCB
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-07(05-06)-1101DQ
Site: BLDG 1
Location: SB-07
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

URS Group Inc.
SLAAP Site-Specific EBS (49-F0K96219.01), St. Louis, MO

Sample #: 01SB-07(05-06)-1101DQ
Site: BLDG 1
Location: SB-07
Matrix: SOIL
Sampler:
Date:
Time:
Methods:
Container: 250 ML GLASS JAR
METALS
Preservative: Cool
Lab: CEWES

FIGURE 5-2

URS Group, Inc.

10975 El Monte, Suite 100
Overland Park, Kansas 66211
(913) 344-1000

SAMPLE COLLECTION FIELD SHEET

Project Name: SLAAP Site-Specific EBS

Project Number: 49F0K96219.01

Sample Number: 01SB-01(05-06)-1101

Personnel: _____

Location: BLDG 1 / SB-01

QA/QC Sample (Circle One): Yes No

Sample Media: SUBSURFACE SOIL

Method: SOIL BORING (GEOPROBE)

Collection Date/Time: YR: _____ MO: _____ DAY: _____ Time: _____

Analyte	Method (Lab Name)	Sample Container	Preservation
Field ID: 01SB-01(05-06)-1101	*QAQC Type: none*		
TPH	SW846-8015B (UNKNOWN)	1-4 oz soil jar	Cool
PCB	SW846-8082 (UNKNOWN)	1-4 oz soil jar	Cool
METALS	SW846-6010B (UNKNOWN)	1-4 oz soil jar	Cool
Field ID: 01SB-01(05-06)-1101DQA	*QAQC Type: DUP-QA*		
TPH	SW846-8015B (CEWES)	1-4 oz soil jar	Cool
PCB	SW846-8082 (CEWES)	1-4 oz soil jar	Cool
METALS	SW846-6010B (CEWES)	1-4 oz soil jar	Cool
Field ID: 01SB-01(05-06)-1101DQC	*QAQC Type: DUP-QC*		
TPH	SW846-8015B (UNKNOWN)	1-4 oz soil jar	Cool
PCB	SW846-8082 (UNKNOWN)	1-4 oz soil jar	Cool
METALS	SW846-6010B (UNKNOWN)	1-4 oz soil jar	Cool

WATER SAMPLE FIELD ANALYSIS

Temperature (C): _____ pH: _____

Conductivity (umhos/cm): _____

Salinity (parts per thousand): _____

Appearance: _____

Odor (Circle One): None Weak Strong

Preserved Sample pH: _____

pH buffer (Before): _____ (After): _____

SOIL SAMPLE OBSERVATIONS

Depth	Description

COMMENTS/SKETCH

FIGURE 5-3

HTW DRILLING LOG

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	HOLE NO. SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED / 11. DATE COMPLETED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE REC. %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
	1 2 3 4 5						

PROJECT:

HOLE NO.:

HTW DRILLING LOG

HOLE NO

PROJECT

INSPECTOR

SHEET

OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

PROJECT:

HOLE NO.:

FIGURE 5-4

VISUAL CLASSIFICATION OF SOILS

)JECT NUMBER:	PROJECT NAME:		
BORING NUMBER:	COORDINATES:		DATE:
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED:
ENGINEER/GEOLOGIST:	Depth	Date/Time	DATE COMPLETED:
DRILLING METHODS:			PAGE OF

DEPTH ( )	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER ( )	RECOVERY ( )	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	WELL CONSTRUCTION	REMARKS

NOTES:

Drilling Contractor _____

Drilling Equipment _____

iller: _____

_____

Test Pit Dimensions – Plan View (If Applicable):

COC No. 011105CEWES01

Chain of Custody Record

Project Name	Project No.
SLAAP Site-Specific EBS	49-F0K96219.01
Project Location	**Project Manager**
St. Louis, Missouri	Bob Skach
Sampler(s)	

01) VOC
02) SVOC
03) PCB
04) Pesticides
05) Metals

Analytical Parameters

Sample Date and Time	Type		Sample Identification (Field ID)	Matrix	No. of containers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Remarks
	Comp.	Grab																								
11/5/2001 13:25:			01SB-01(00-01)-1101DQA	SOIL	2					X																
11/5/2001 14:40:			01SB-02(09-10)-1101DQA	SOIL	2			X																		
11/5/2001 16:15:			01SB-07(05-06)-1101DQA	SOIL	4			X		X																

FIGURE 5-5

Signatures	Date and Time	Shipping Details	Special Instructions
Relinquished by:		Method of Shipment: Federal Express	
Received by:		Airbill No. 1122334455667788	
Relinquished by:		Lab Addresses: CEWES-COA Branch Lab, 420 S 18th Street, Omaha, NE 68102	
Received for Laboratory by:			

FIGURE 5-6

COOLER RECEIPT FORM

LIMS #: _____ Contractor Cooler: _____

QA Lab Cooler No.: _____

Number of Coolers: _____

PROJECT: _____ Date Received: _____

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. **PRELIMINARY EXAMINATION PHASE:** Date cooler was opened: _____

by (print) _____ (sign) _____

1.	Did cooler come with a shipping slip (air bill, etc.)?	YES	NO
	If YES, enter carrier name and air bill number here: _____		
2.	Were custody seals on outside of cooler?	YES	NO
	How many and where: _____, seal date: _____, seal name _____		
3.	Were custody seals unbroken and intact at the date and time of arrival?	YES	NO
4.	Did you screen samples for radioactivity using the Geiger Counter	YES	NO
5.	Were custody papers sealed in a plastic bag and taped inside to the lid?	YES	NO
6.	Were custody papers filled out properly (ink, signed, etc.)?	YES	NO
7.	Did you sign custody papers in the appropriate place?	YES	NO
8.	Was project identifiable from custody papers? If YES, enter project name at the top of this form.	YES	NO
9.	If required, was enough ice used?	YES	NO
	Type of Ice: _____		
10.	Have designated person initial here to acknowledge receipt of cooler: _____ (date) _____		

B. **LOG-IN PHASE:** Date samples were logged-in: _____

by (print) _____ (sign) _____

11.	Describe type of packing in cooler: _____		
12.	Were all bottles sealed in separate plastic bags?	YES	NO
13.	Did all bottles arrive unbroken and were labels in good condition?	YES	NO
14.	Were all bottle labels complete (ID, date, time, signature, preservative, etc.)?	YES	NO
15.	Did all bottle labels agree with custody papers?	YES	NO
16.	Were correct containers used for the tests indicated?	YES	NO
17.	Were correct preservatives added to samples?	YES	NO
18.	Was a sufficient amount of sample sent for tests indicated?	YES	NO
19.	Were bubbles absent in VOA samples? If NO, list by CAS: _____	YES	NO
20.	Was the project manager called and status discussed? If YES, give details on the back of this form.	YES	NO
21.	Who was called? _____ By whom? _____ (Date) _____		

FIGURE 8-1

DAILY FIELD REPORT

Client: USACE Contract No.: DACW41-96-D-8014, Task Order 0019 Date: ________ Report No.: ________

Description and Type of Work: ________

Sky: ________ Temp (min/max): ____/____ Precip: ________ Wind (speed/direction): ____/____ Humidity: ____

Contractor/Subcontractors and Area of Responsibility

a.

b.

c.

d.

e.

f.

g.

1. Work Performed Today: Indicate location and description of work performed. Refer to work performed by prime and/or subcontractors by letter in table above.

Time	Activity

2. Results of Surveillance: Include satisfactory work completed, or deficiencies with action to be taken.

3. Tests performed and results of tests (per contract documents)

4. Remarks: Cover instructions or conflicts in plans and specifications

5. Time and materials furnished by URS (Itemized report attached for other staff and expenses)

Total Hours Worked _____ Special Charges _____

Mileage _____ _____

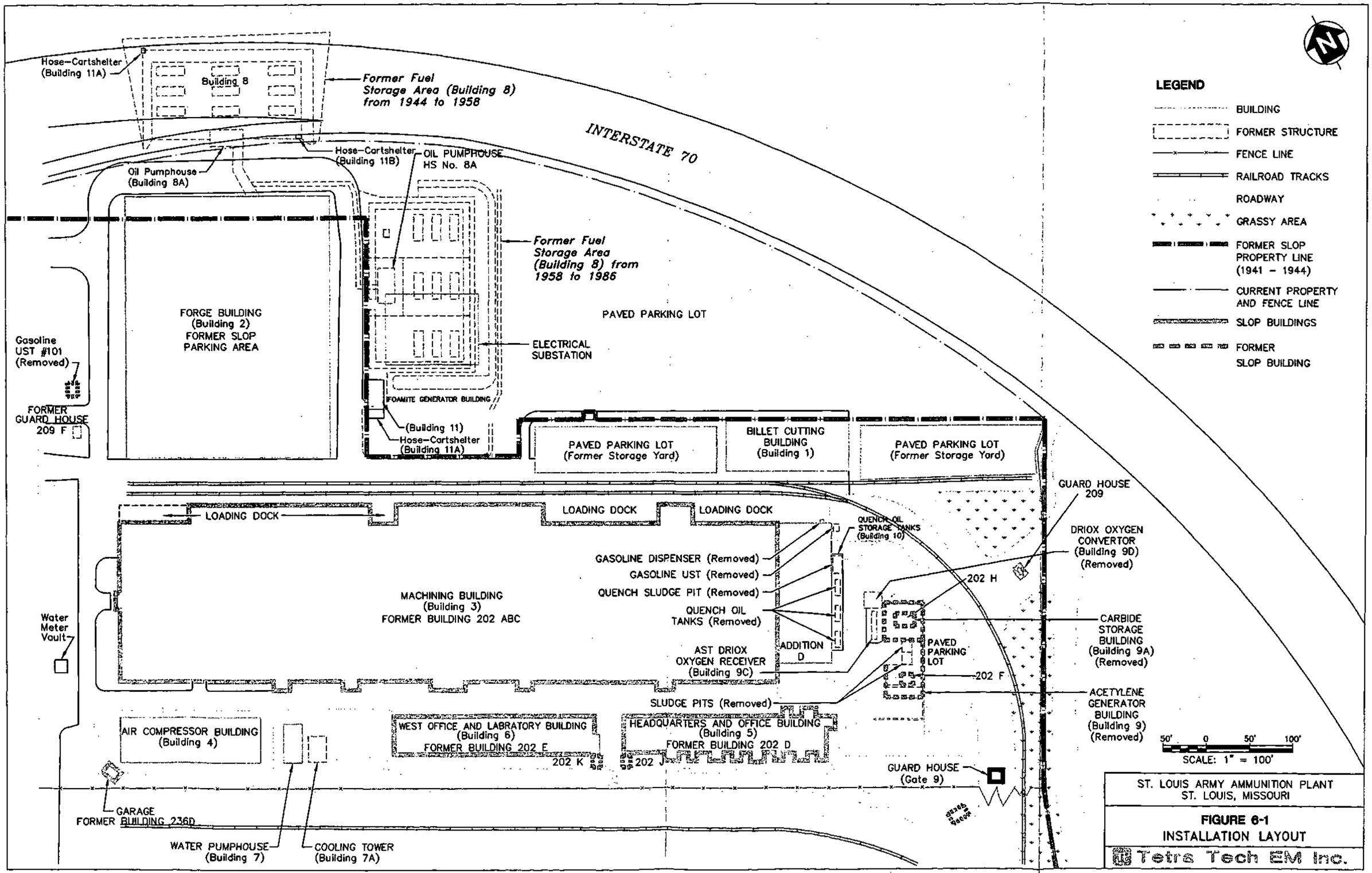
Expenses _____ _____

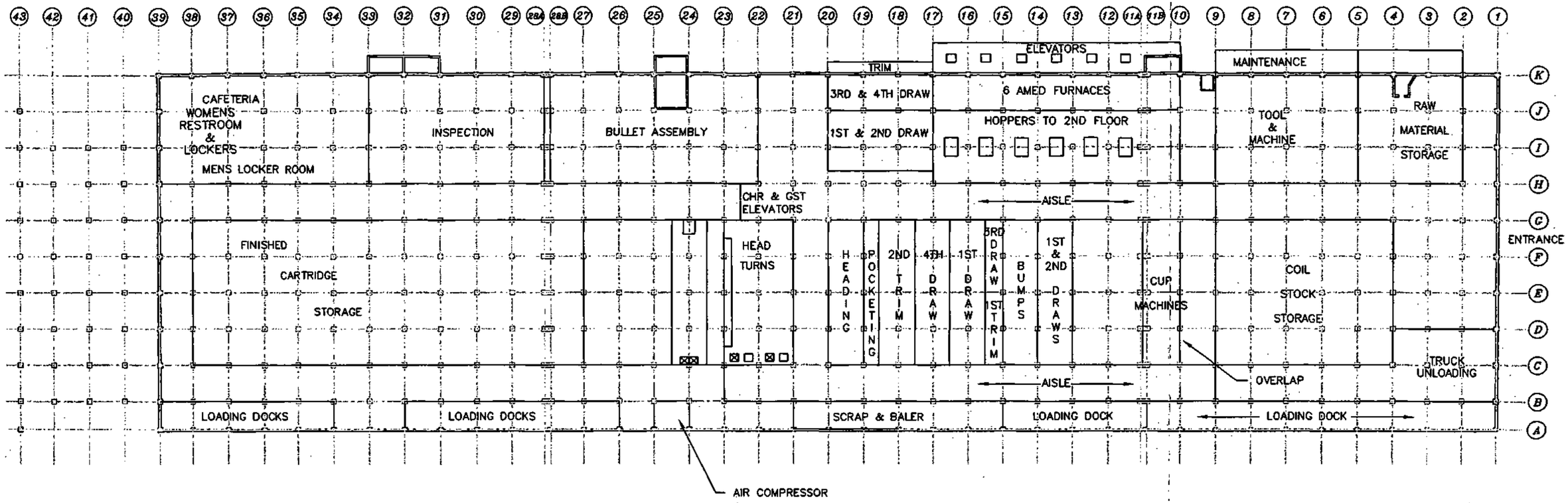
Prepared by: _____

Owners Verification: The above report is complete and correct and all material and equipment used and work performed during this reporting period are in compliance with the contract documents except as noted above.

Report Period _____ Date: _____

Owner's Authorized Representative

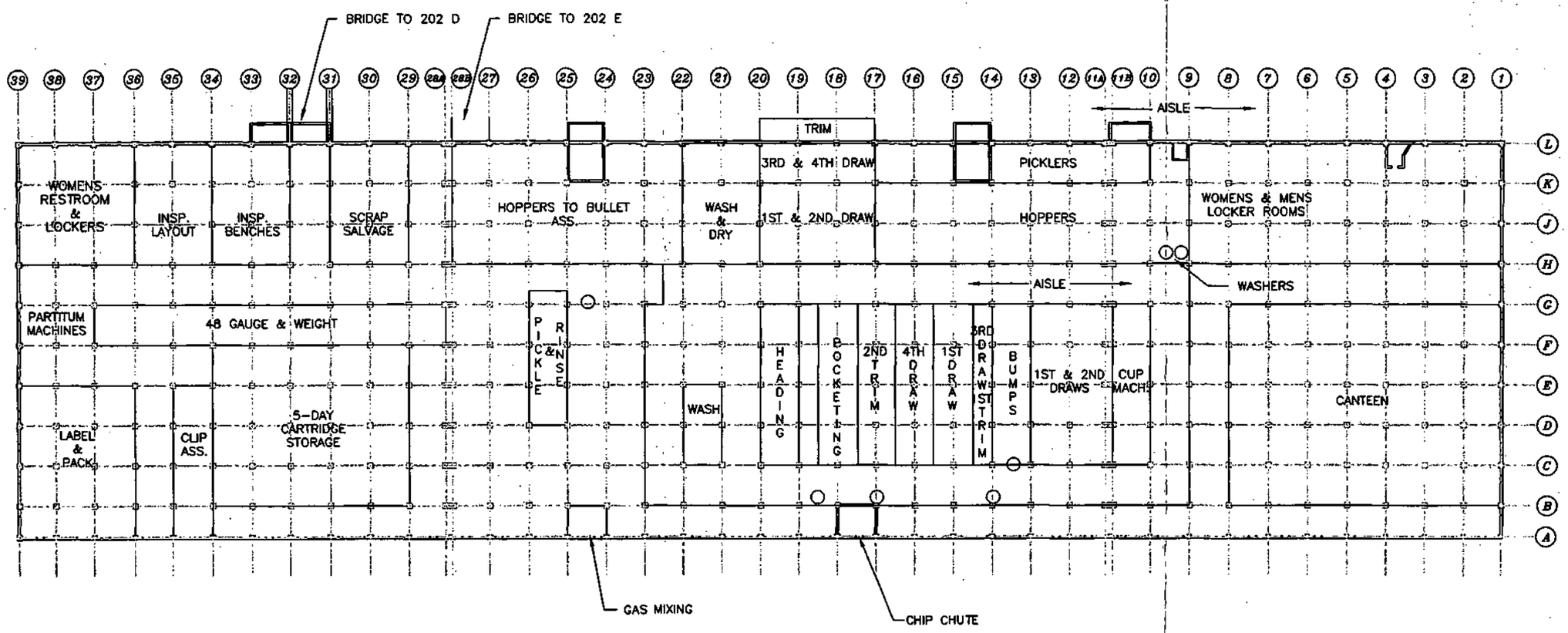

Hose-Cartshelter (Building 11A)
Building 8
Former Fuel Storage Area (Building 8) from 1944 to 1958
INTERSTATE 70
Hose-Cartshelter (Building 11B)
OIL PUMPHOUSE HS No. 8A
Oil Pumphouse (Building 8A)
Former Fuel Storage Area (Building 8) from 1958 to 1986
FORGE BUILDING (Building 2) FORMER SLOP PARKING AREA
PAVED PARKING LOT
ELECTRICAL SUBSTATION
Gasoline UST #101 (Removed)
FOAMITE GENERATOR BUILDING
(Building 11)
Hose-Cartshelter (Building 11A)
FORMER GUARD HOUSE 209 F
PAVED PARKING LOT (Former Storage Yard)
BILLET CUTTING BUILDING (Building 1)
PAVED PARKING LOT (Former Storage Yard)
LOADING DOCK
LOADING DOCK
LOADING DOCK
QUENCH OIL STORAGE TANKS (Building 10)
GUARD HOUSE 209
DRIOX OXYGEN CONVERTOR (Building 9D) (Removed)
GASOLINE DISPENSER (Removed)
GASOLINE UST (Removed)
QUENCH SLUDGE PIT (Removed)
QUENCH OIL TANKS (Removed)
MACHINING BUILDING (Building 3) FORMER BUILDING 202 ABC
202 H
Water Meter Vault
ADDITION D
AST DRIOX OXYGEN RECEIVER (Building 9C)
PAVED PARKING LOT
CARBIDE STORAGE BUILDING (Building 9A) (Removed)
202 F
SLUDGE PITS (Removed)
ACETYLENE GENERATOR BUILDING (Building 9) (Removed)
AIR COMPRESSOR BUILDING (Building 4)
WEST OFFICE AND LABRATORY BUILDING (Building 6) FORMER BUILDING 202 E
202 K
HEADQUARTERS AND OFFICE BUILDING (Building 5) FORMER BUILDING 202 D
202 J
GUARD HOUSE (Gate 9)
GARAGE FORMER BUILDING 236D
WATER PUMPHOUSE (Building 7)
COOLING TOWER (Building 7A)
LEGEND
BUILDING
FORMER STRUCTURE
FENCE LINE
RAILROAD TRACKS
ROADWAY
GRASSY AREA
FORMER SLOP PROPERTY LINE (1941 - 1944)
CURRENT PROPERTY AND FENCE LINE
SLOP BUILDINGS
FORMER SLOP BUILDING
50' 0 50' 100'
SCALE: 1" = 100'
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
FIGURE 6-1
INSTALLATION LAYOUT
Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOIUS, MISSOURI

FIGURE 6-2
BUILDING 202 ABC 1ST FLOOR
PRE 1944 LAYOUT

Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-3
BUILDING 202 ABC 2ND FLOOR
PRE 1944 LAYOUT

Tetra Tech EM Inc.

FORMER SLOP BUILDING 202 ABC
(BUILDING 3)

SECOND
FLOOR
BRIDGES
FROM BUILDING 3

FORMER PRIMER INSERT MACHINES AREA

FORMER
PRIMER
INVERT
MACHINES

FORMER SLOP BUILDING 202 E
(BUILDING 6)

PL

A/C

CONVEYOR TO
2ND FLOOR OF
BUILDING 202ABC

A/C PL A/C PL A/C PL A/C PL

FORMER SLOP BUILDING 202 D
(BUILDING 5)

20' 0 20' 40'
SCALE: 1" = 40'

LEGEND

- BUILDING
- FENCE LINE
- ROADWAY
- ⊠ FORMER ELEVATOR
- O FORMER SPIRAL CHUTE
- PL FORMER POWDER LOADING
- A/C FORMER BUCKET ASSEMBLE AND CRIMP
- ▦ PRIMER INVERT MACHINE

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-4
BUILDINGS 202 D AND 202 E - FIRST FLOOR
PRE 1944 LAYOUT

Tetra Tech EM Inc.

INTERSTATE 70

OVERHEAD CRANE

PARKING
LOT
(billet storage area)

BILLET CUTTING BUILDING (BUILDING 1)

BREAKING MACHINES

N

OFFICE | SAWS | GRIND | RESTROOM

OVERHEAD CRANE

PARKING
LOT
(billet storage area)

LEGEND

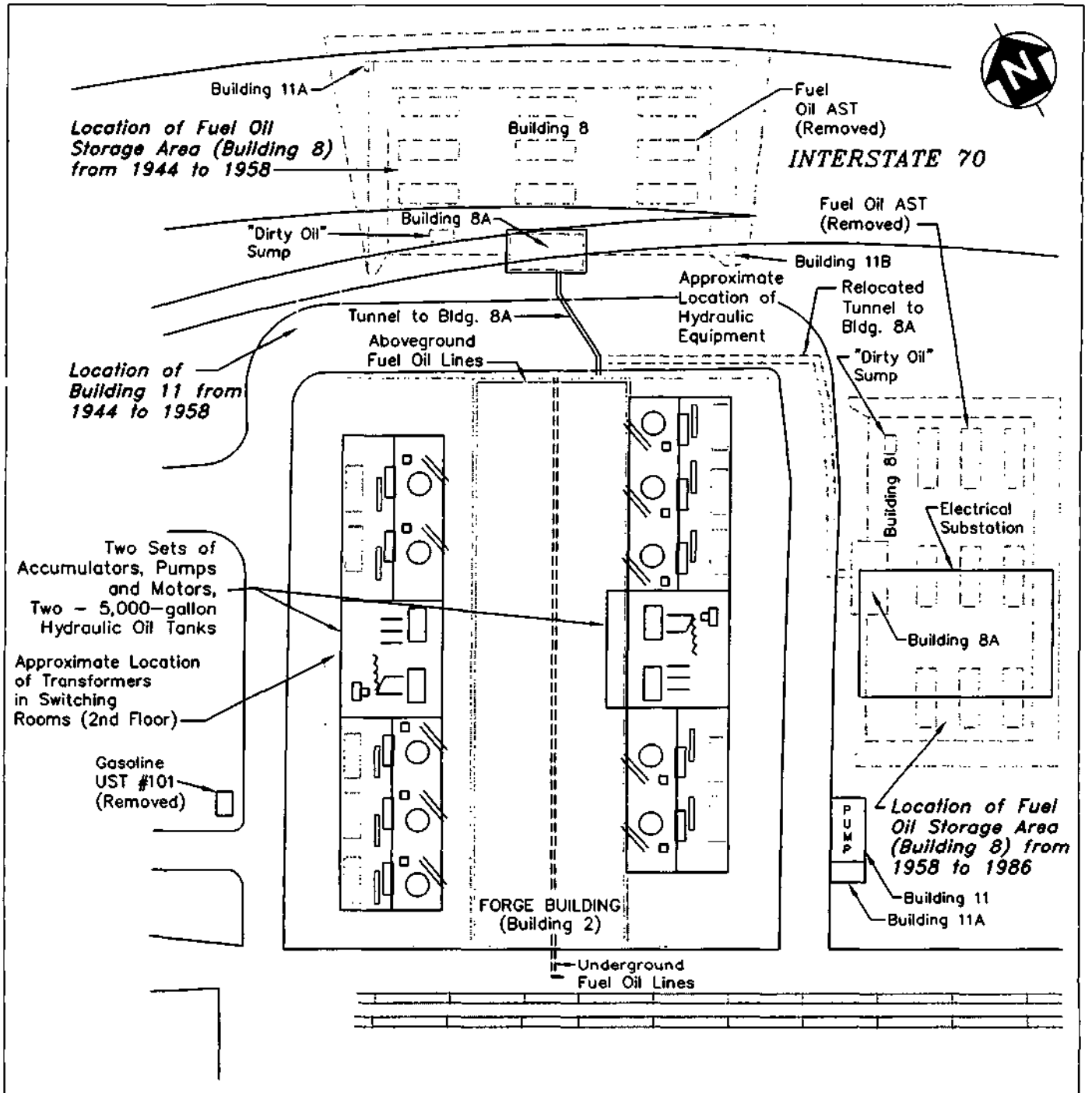
- BUILDING
- FENCE LINE
- RAILROAD TRACKS
- ROADWAY
- N NICKING MACHINE
- I INSPECTION AREA

20' 0 20' 40'
SCALE: 1" = 40'

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-5
BUILDING 1
MAJOR EQUIPMENT LAYOUT

Tetra Tech EM Inc.



LEGEND

- BUILDING
- FORMER STRUCTURE
- FENCE LINE
- RAILROAD TRACKS
- ROADWAY
- ROTARY FURNACE
- SKID CONVEYOR
- DRAW BENCH
- QUENCH TANK
- PIERCING PRESS
- SIZE DESCALE

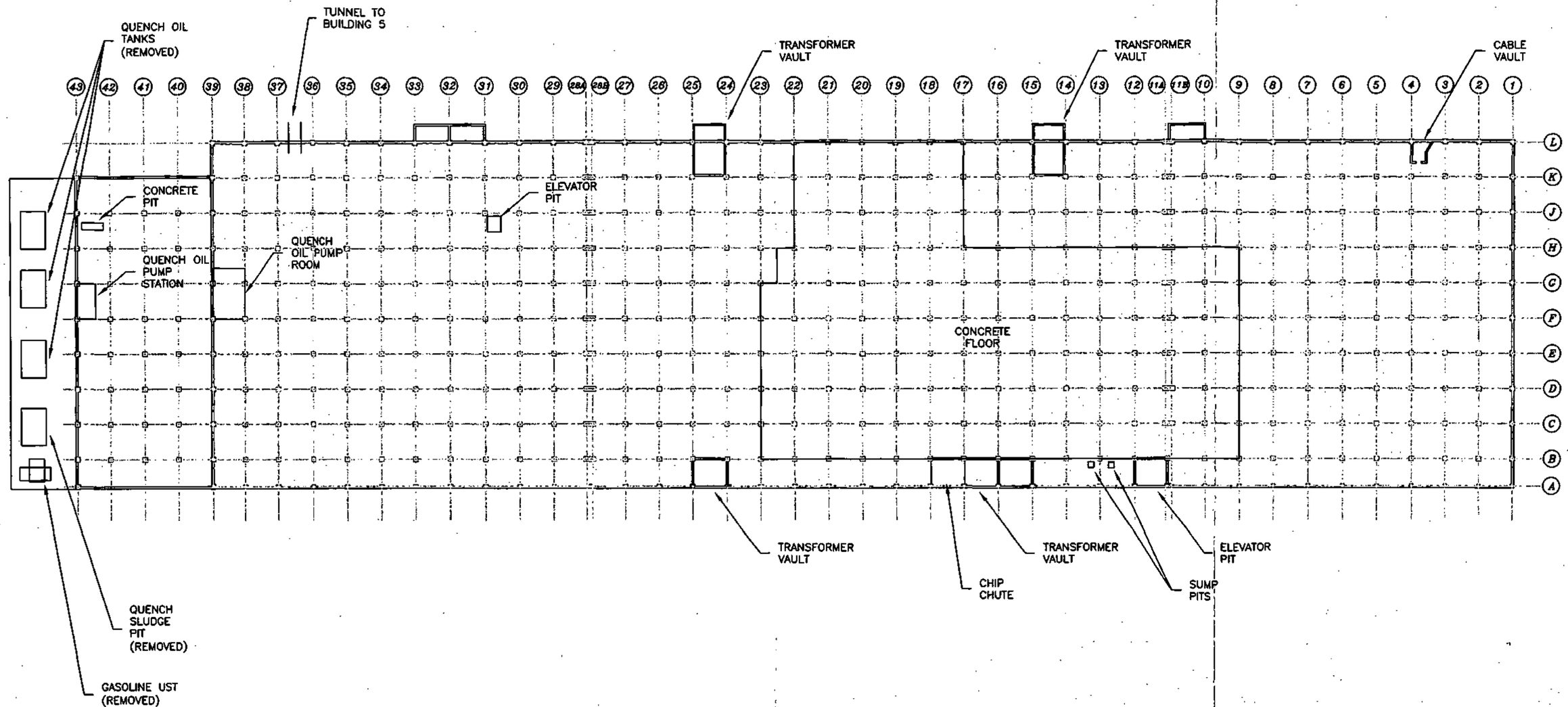
25' 0 25' 50'

SCALE: 1" = 50'

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-6
BUILDINGS 2, 8, 8A, 11, AND 11A
MAJOR EQUIPMENT LAYOUT

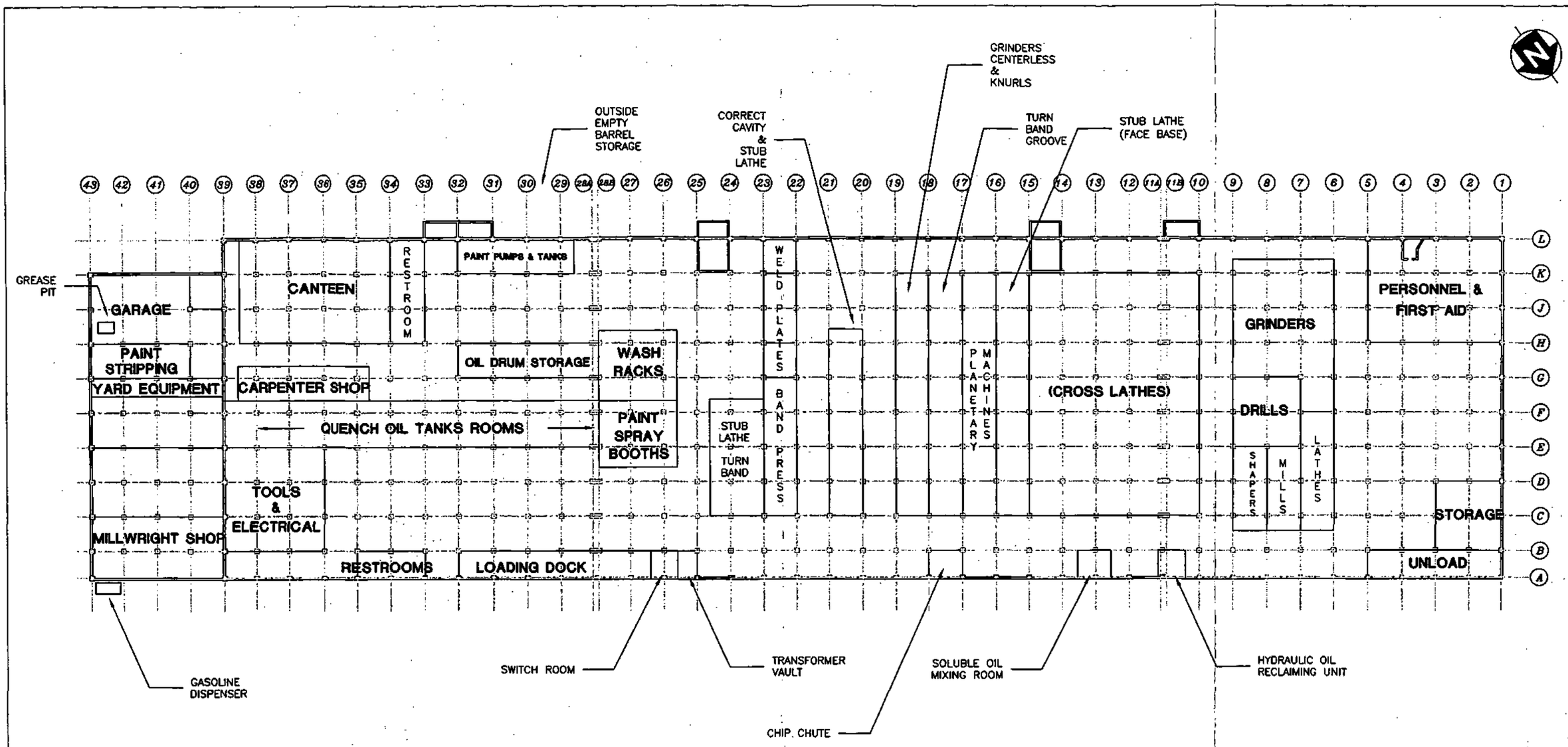
Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-7
BUILDING 3 BASEMENT

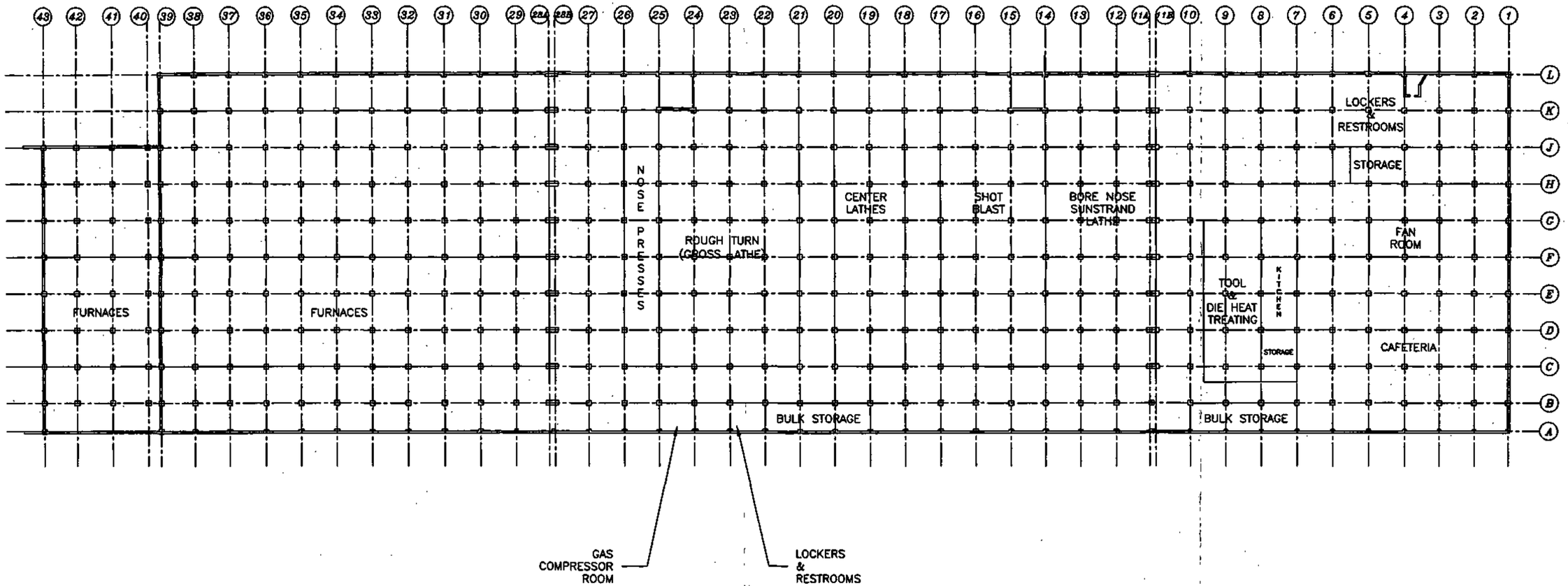
Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-8
BUILDING 3 1ST FLOOR
POST 1944 LAYOUT

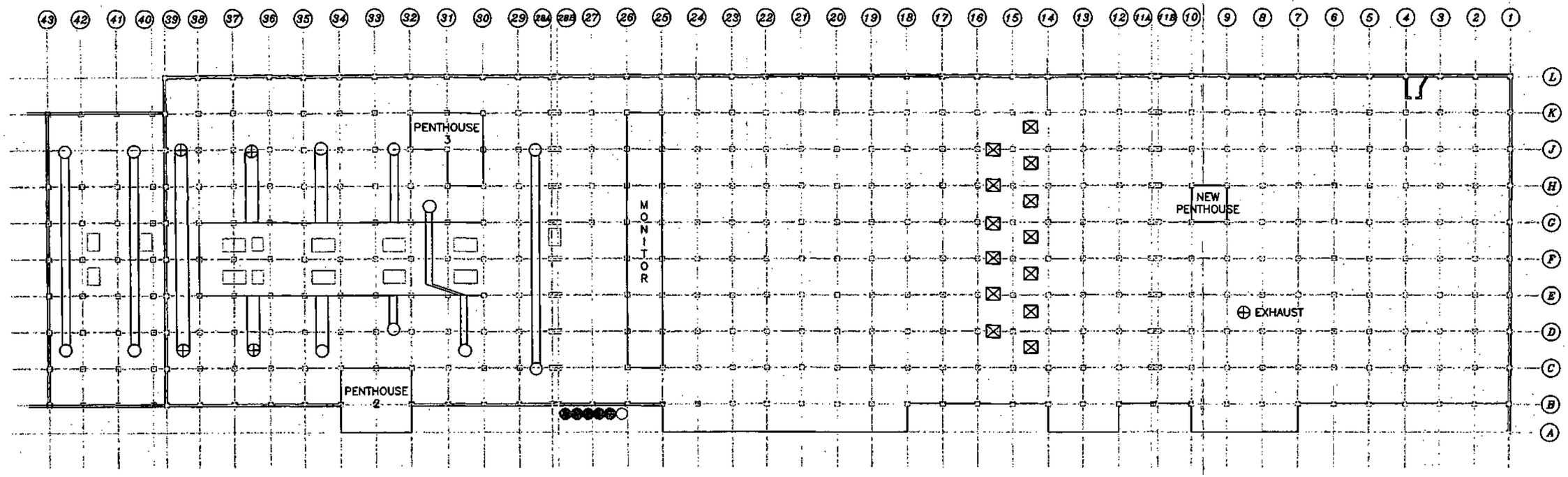
Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-9
BUILDING 3 2ND FLOOR
POST 1944 LAYOUT

Tetra Tech EM Inc.



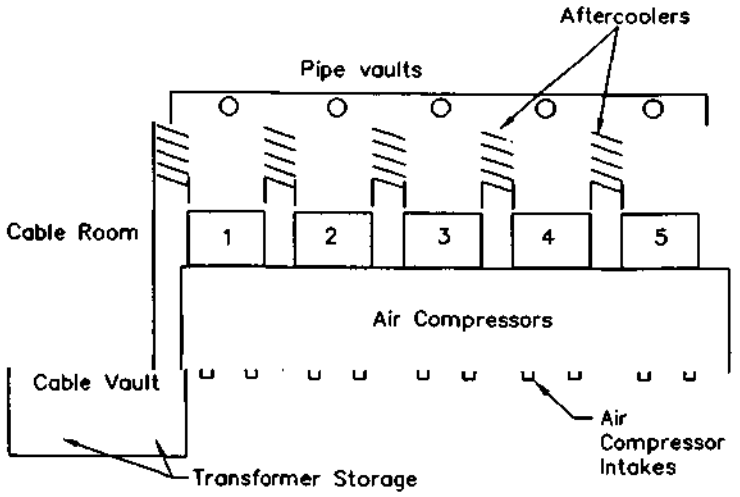
LEGEND

- COOLING TOWER
- PAINT ROOM EXHAUST FAN
- EXHAUST FANS WITH DUCT WORK
- DUST COLLECTORS
- PAINT SPRAY BOOTH EXHAUST FANS
- WASHER EXHAUST FAN

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-10
BUILDING 3 ROOF

Tetra Tech EM Inc.



Building 7A
Cooling
Tower
Cold
Well

LEGEND

- BUILDING
- FORMER STRUCTURE
- FENCE LINE
- RAILROAD TRACKS
- ROADWAY
- AIR RECEIVER

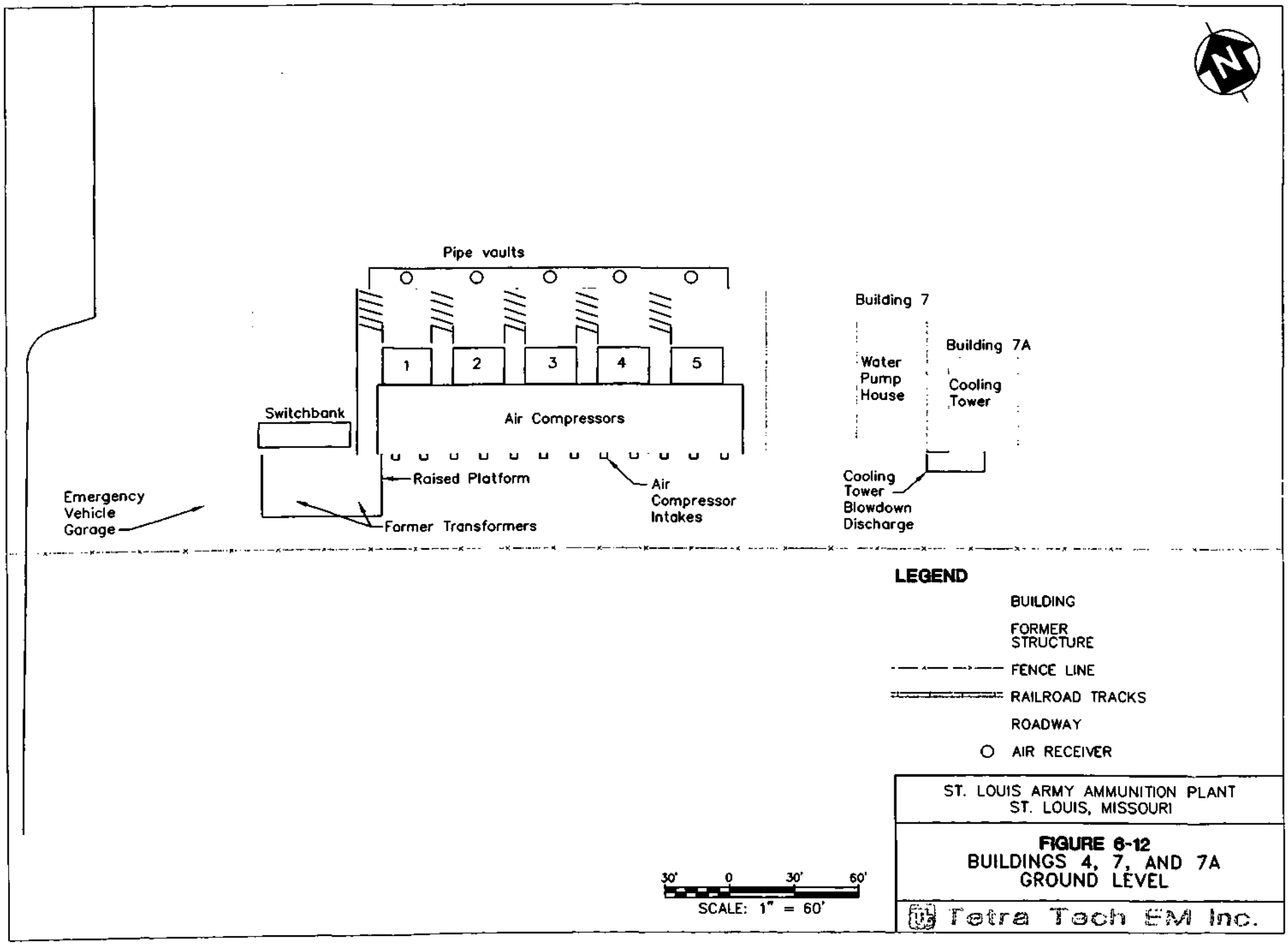
30' 0 30' 60'

SCALE: 1" = 60'

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-11
BUILDINGS 4 AND 7A
BASEMENT
MAJOR EQUIPMENT LAYOUT

Tetra Tech EM Inc.



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-12
BUILDINGS 4, 7, AND 7A
GROUND LEVEL

Tetra Tech EM Inc.

WEST OFFICE AND LABORATORY BUILDING
(Building 6)

Chemical Department

Locker Room

Offices

Government Inspection

Offices

Inspection Department

Physical Department

Dark Room

Chemical Strorage

Laboratory

Deep Etch Fume Hood

HEADQUARTERS AND OFFICE BUILDING
(Building 5)

Shower

Aisle

Lobby

Restroom

Conference Room

Offices

Storage

LEGEND

BUILDING

FENCE LINE

ROADWAY

20' 0 20' 40'

SCALE: 1" = 40'

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 6-13
BUILDINGS 5 AND 6
POST 1944 LAYOUT

Tetra Tech EM Inc.

DRAFT

PART II
QUALITY ASSURANCE PROJECT PLAN
SITE-SPECIFIC ENVIRONMENTAL BASELINE SURVEY
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
CONTRACT NO. DACW41-96-D-8014
TASK ORDER 0019

Prepared for
Department of the Army
U.S. Army Engineer District
Kansas City District
Corps of Engineers
Kansas City, Missouri

August 2001

URS

URS Corporation
10975 EL MONTE, SUITE 100
OVERLAND PARK, KANSAS 66211

Project No. 49-F0K96219.01

QUALITY ASSURANCE PROJECT PLAN

ST. LOUIS ARMY AMMUNITIONPLANT, ST. LOUIS, MISSOURI

CONTRACT NO. DACW41-96-D-8014

Approval Sheet

Robert F. Skach, PE, Project Manager	Date
Dana J. Monroe, Project QA/QC Officer	Date
Bradley Eaton, CENWK Project Manager	Date
CENWK QA/QC Officer	Date

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Appendices

LIST OF ACRONYMS

ACM	asbestos containing materials
AMCCOM	U.S. Army Armament, Munitions and Chemical Command
AMCOM	U.S. Army Aviation and Missile Command
ATCOM	U.S. Army Aviation and Troop Command
AVSCOM	U.S. Army Aviation Systems Command
CENWK	Kansas City District Office of the U.S. Army Corps of Engineers Northwest Division
CLP	Contract Laboratory Program
COC	chain-of-custody
CX	Center of Expertise
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
DRO	diesel range organics
EBS	Environmental Baseline Survey
EPA	Environmental Protection Agency
FOST	Finding of Suitability to Transfer
FSP	Field Sampling Plan
GC/MS	gas chromatography/mass spectrometry
GRO	gasoline range organics
HTRW	Hazardous, Toxic, and Radioactive Waste
ID	identification
IDW	investigation-derived waste
LBP	lead based paint
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOR	Letter-of-Receipt
MDNR	Missouri Department of Natural Resources
MDL	method detection limit
mm	millimeter
MS	matrix spike

LIST OF ACRONYMS

MSD	matrix spike duplicate
NCR	Nonconformance Report
NON	Notice of Noncompliance
NVLAP	National Voluntary Laboratory Accreditation Program
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PFE	Plant Facilities and Engineering, Inc.
PID	photo ionization detector
PLM	polarized light microscopy
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SHERP	Safety, Health and Emergency Response Plan
SLAAP	St. Louis Army Ammunition Plant
SLOP	St. Louis Ordnance Plant
SOP	standard operating procedure
SQL	sample quantitation limit
SVOC	semi-volatile organic compound
TIC	tentatively identified compound
TPH	total petroleum hydrocarbon
USACE	U.S. Army Corps of Engineers
URS	URS Group, Inc.
UST	underground storage tank
VOC	volatile organic compound
%R	percent recovery

This portion (Part II) of the Sampling and Analysis Plan (SAP) consists of the Quality Assurance Project Plan (QAPP). This document was prepared by URS Group, Inc. (URS) under Task order 0019 of Contract DACW41-96-D-8014 with the Kansas City District U.S. Army Corps of Engineers (CENWK) on behalf of the U.S. Army Aviation and Missile Command (AMCOM), Huntsville, AL. The QAPP will be used to guide analytical and quality assurance/quality control (QA/QC) activities during field work of the Site Specific Environmental Baseline Study (SSEBS) at the Saint Louis Army Ammunition Plant (SLAAP) (refer to Appendix A, Figure 6-1 of the Field Sampling Plan (FSP) for a site map of SLAAP). The CENWK, the United States Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR) require participation in a centrally managed quality assurance (QA) program for environmental monitoring efforts. Any party generating data for an environmental monitoring project has the responsibility to implement procedures to ensure that the data is of adequate quality (in terms of precision, accuracy, representativeness, completeness, comparability and sensitivity) and that the data is appropriately documented. To ensure these responsibilities are met, parties involved in the project must adhere to the requirements specified in this QAPP.

The FSP portion (Part I) of this SAP contains detailed descriptions of, among other things, the site layout and history, project scope and objectives, planned sampling activities, sampling rationale, number of samples, and sampling methods. This QAPP (Part II of the SAP) presents a detailed discussion of the analytical and QA/QC activities associated with the SLAAP effort, including data quality objectives, analytical methods, field QA/QC sampling, laboratory QC checks, laboratory calibration procedures, and data validation and reporting. Despite covering different aspects of the project, the contents of each plan are not mutually exclusive. It is intended that the QAPP and FSP be used jointly for purposes of project management.

It should be noted that analytical activities and methodologies associated with analysis of QA split samples to be performed by CENWK, EPA or MDNR at a government-designated laboratory are not addressed within this document. This QAPP applies to Contractor analytical requirements only. However, the collection of the QA split samples by URS is addressed herein.

1.1 PROJECT ORGANIZATION

Activities described in this QAPP will be performed at SLAAP by URS. General project organization is given in Section 2 of the FSP and the responsibilities of each position pertinent to the project are described below.

- **Project Manager (Robert Skach)** – will be responsible for interacting with CENWK on regulatory, technical, and financial matters as well as assisting CENWK with establishing project direction and objectives. The Project Manager will monitor adherence to project schedules, the development, maintenance, and safekeeping of project documentation, and has the ultimate authority for implementation of field investigations as well as other technical project activities The Project Manager will also provide senior level review on all project deliverables.
- **Project QA/QC Officer (Dana Monroe)** – will be responsible for review of field and laboratory data, for compliance with quality assurance/quality control (QA/QC) objectives (precision, accuracy, completeness, comparability and sensitivity) and suitability as reportable values of site data and reporting any data deficiencies to project management.

- **Field Teams** – URS field teams will consist of a field team leader directing field team members for activities described herein. The field team leader will assure that the field team members collect samples in accordance with the QAPP and referenced project plans.
- **Laboratory Project Manager** – will be responsible for monitoring workloads, ensuring availability of resources, and overseeing the preparation of laboratory reports.
- **Laboratory QA/QC Officer** – will provide periodic review and inspection of all project activities as an independent QA/QC officer and may conduct audits of project activities.

1.2 PROJECT BACKGROUND

The St. Louis Ordnance Plant (SLOP) was constructed in 1941. SLOP was a 276-acre, small arms ordnance plant that produced 0.30- and 0.50-caliber munitions. In 1944, 21.05 acres in the northeast portion of SLOP were converted from small arms ammunition production to 105-millimeter (mm) Howitzer shell production and were designated as SLAAP. Currently, the SLAAP property contains eight unoccupied buildings that were used to house SLAAPs main operating processes.

After World War II, SLAAP was placed on standby status. It was reactivated from Nov 1951 to Dec 1954 and again from Nov 1966 to Dec 1969 to support 105-mm Howitzer shell production. The plant was maintained and operated by the Chevrolet Shell Division of General Motors from 1951 until 1958, by the U.S. Defense Corporation from 1958 to 1966, and by the Chevrolet Motor Division of General Motors from 1966 until 1972, when Donovan Construction Company was awarded the maintenance and surveillance contract.

In 1984, buildings at SLAAP were renovated to house filing and administrative operations by more than 500 personnel from the U.S. Army Aviation Systems Command (AVSCOM). From 1986 to 1990, SLAAP was under the command of the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM). In 1989, the Department of the Army determined that SLAAP was no longer required to support its munitions mission, and most industrial equipment was removed from the plant. In 1990, plant ownership and control were placed under the U.S. Army Aviation and Troop Command (ATCOM). As of 1993, SLAAP maintenance and surveillance activities were being subcontracted by Donovan Construction Company to Plant Facilities and Engineering, Inc. (PFE). Since 1998, SLAAP has been vacant and under the control of AMCOM.

A record search and initial site visit was conducted as part of the comprehensive Environmental Baseline Survey (EBS) to identify possible areas of environmental concern at SLAAP. The record search indicates that a Notice of Noncompliance (NON) was issued by the EPA Region VII to SLAAP for polychlorinated biphenyl (PCB) contamination in Building 3. To date, this NON has not been resolved. AMCOM has reviewed this NON with EPA Region VII and contracted the USACE to remediate the PCB contamination in Building 3. Records also indicate that underground storage tank (UST) removals at SLAAP have not been closed. Possible sitewide areas of environmental concern consist of contamination resulting from possible contaminant migration from the PURO Chemical storage facility (formerly part of SLOP) located south of the installation, as well as friable asbestos-containing materials (ACM), lead-based paint (LBP) and PCBs contained in original fluorescent light ballasts found at SLAAP.

The following building-specific possible areas of environmental concern were identified through the records reviewed and the initial site visit:

- Electrical equipment in Buildings 1, 2, and 4 have oils suspected of containing PCBs.
- Spilled oil was identified in Buildings 1, 2, 3, and 5.
- Concrete-filled hydraulic oil pits, sumps, and floor drains were identified in Building 1.
- Two pits connected to the sewer system were observed at Building 1.
- Debris was present throughout Buildings 1, 2, and 4.
- Building 2 contained subgrade pipes for distributing hydraulic oil with PCB's.
- Soil near the chip chute in the basement of Building 3 is suspected of containing PCBs and pesticides.
- Oil staining was present along the far east foundation wall, on the floor, and on support columns in the vicinity of the quench oil pump room in the basement of Building 3.
- Suspect ACM and suspect PCB-contaminated metal shavings were observed on the basement floor of Building 3.
- A steel separator tank was identified in the south-central portion of the basement of Building 3. The tank was filled with a dried, oxidized material. This material may be of environmental concern. Other pieces of equipment were located in the basement.
- Cracks in the PCB remediated concrete cap were observed on the first floor of Building 3.
- Paint used to seal the steel structures on the first floor of Building 3 was cracking and peeling.
- A solvent room with a drain connected to the sewer system was identified in Building 3 plans.
- A room on the second floor of Building 3 contained an emergency power supply unit. This unit may contain lead-acid or nickel-cadmium batteries.
- A remote quench oil-fill pipe was located near the northeast corner of Building 3.
- The compressor pits in Building 4 are suspected of containing compressor oil with PCB's.
- Ash was observed in a hearth in Building 6.
- The aboveground storage tanks formerly present at Building 8, east of Building 2, are suspected of having leaked and spilled fuel oil.
- USTs have not been officially closed, and may present a possible environmental concern.

This QAPP presents quality assurance guidelines for the collection and analysis of samples to further delineate the extent of contamination and perform a risk assessment at the site. This QAPP has been prepared with guidance available from SW-846 and in general accordance with industry standards.

This QAPP precludes any existing quality plans for this site and will be followed from this point forward.

1.3 PROJECT DESCRIPTION

Activities addressed under this QAPP include the collection and analysis of concrete borings, soil samples, water samples, air samples and sewer/sump sediment samples by URS to further characterize the extent of contamination at the site and to provide data to perform a human health risk assessment. The results of the site characterization and risk assessment may be used to support a Finding of Suitability to Transfer (FOST) for the property. Potential site buyers may also be presented with the results of this project in order to assist in decisions about possible site ownership.

A description of the sampling program is referenced in the FSP.

Based on the data quality objective (DQO) design process, a project-specific sampling and analysis program was developed and is summarized in Table 3-1 of the FSP. The sampling effort to be performed at SLAAP will involve collection of samples for the following purposes consistent with the project objectives:

- Samples collected for PCB identification (quantity and volume estimates)
- Samples collected for verification of oil-staining as a selection criteria for PCB contamination
- Samples collected for remediation waste pre-determination
- Samples collected for health and safety pre-assessment
- Samples collected for health and safety monitoring
- Samples collected for investigation-derived waste (IDW) characterization

This sampling program will involve the collection of samples from the following media type:

- Concrete
- Soil
- Water
- Sediment
- Wipes
- IDW water samples
- ACM
- Filter cassettes (air monitoring)

Areas of SLAAP to be sampled are identified on Figures 3-1thru 3-11 of the FSP. The rationale for the selection of these areas is discussed in detail in Section 3.0 of the FSP. Sampling methods are discussed in Section 4.0 of the FSP. Estimates of the number of samples to be collected by media type are presented in Table 3-2 of the FSP. Additional portions of select samples will be collected to meet QA/QC requirements, including duplicates, QA split samples, and field blanks. The collection frequencies for field QA/QC samples are presented in Table 1.

Samples will be analyzed for the following parameters:

- Volatile Organic Compounds (VOCs)
- Semi-volatile Organic Compounds (SVOCs)
- Polynuclear Aromatic Hydrocarbons (PAHs)
- Explosives
- PCBs
- Pesticides
- Total Metals
- Mercury
- Hexavalent Chromium
- Gasoline range organics (GROs) and diesel range organics (DROs)
- Nitrate
- Phosphorus
- Asbestos
- Crystalline silica

The SW-846 and EPA methods that will be used to analyze samples for these parameters (excluding asbestos and silica) are presented in Table 3. Sample container, sample volume, preservation and holding time requirements for the analytical parameters are also presented in Table 3.

Refractory brick samples will be collected and sent to a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory to be analyzed for asbestos by polarized light microscopy (PLM). Filter cassettes from air monitoring activities will be analyzed for crystalline silica using NIOSH Method 7500. The remainder of this QAPP applies primarily to analysis of site samples by SW-846 and EPA methods. Further details regarding health and safety monitoring are discussed in the Safety, Health and Emergency Response Plan (SHERP).

1.4 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements derived from the DQO process that specify, from an end users perspective, the quality of data required to support decisions made during investigative activities. The DQOs specify the maximum level of uncertainty the user is willing to accept in order to accurately make project decisions. DQOs are developed prior to data collection and should be specified for all data collection activities that take place.

1.4.1 Project Quality Objectives

The underlying objective with respect to data quality is to generate data that is technically sound and legally defensible. In terms of the SLAAP sampling effort, the specific objectives are to:

- Provide additional analytical data for site characterization.

- Provide sufficient data to complete a human health risk assessment.
- Identify areas and quantities of contamination that may be included in a possible remedial action.
- Verify that oil staining is a reliable indicator for identifying PCB contamination in basement soils.
- Pre-determine the waste characteristics of concrete, waste material (Chip Chute Waste pile and catch basins), and soil (basement floor and outside adjacent to Chip Chute) for potential removal and off-site disposal during a subsequent remedial action.
- Pre-assess the health and safety concerns (i.e. personnel exposure) associated with concrete, waste, and soils to support planning for a possible remedial action.
- Assess personnel exposure to silica from potential dust-generating activities during the SLAAP sampling effort
- Characterize IDW (decontamination water) from the SLAAP sampling effort to determine proper disposal methods.

This is to be accomplished through the proper implementation of the field sampling procedures, chain of custody (COC) documentation, controlled laboratory analysis, and validation of the reported data prior to their use. The necessary procedures for field sampling and COC are discussed in the FSP. Procedures for laboratory analysis and data validation are discussed in other sections of this QAPP.

1.4.2 Measurement Performance Criteria

The following sections discuss the QA parameters that will be used to ensure that the data quality objectives are met. Quantitative evaluation procedures and the required frequency for these and other QC checks are presented in the Standard Operating Procedures (SOPs) included in Appendix A. The SOPs also include a list of corrective actions that will be followed if the QC criteria are not satisfied. The corrective actions range from qualification of the results to reanalysis of the samples.

- **Precision** - Precision for the laboratory analyses will be evaluated using the relative percent difference (RPD) between the results of a laboratory control sample (LCS) and a laboratory control sample duplicate (LCSD), a matrix spike (MS) and a matrix spike duplicate (MSD) and laboratory duplicates. Precision for the fieldwork is evaluated using the RPD between the results of field duplicate samples. The formula for calculating RPD is given in Section 2.4.1. The acceptance criteria are given in Table 1 and the SOPs.
- **Accuracy** - Accuracy will be evaluated using the percent recoveries (%R) of LCS/LCSDs, MS/MSDs and surrogate compounds (if required by the method). The formula for calculating %R is given in Section 2.4.2. The method specific criteria are given in Table 1 and the SOPs.
- **Completeness** - Completeness is the measure of the degree to which the project requirements for sample collection, usability and data quality have been met. For sample collection, completeness is the ratio of the number of samples actually taken to the number of samples planned to be taken. The goal for completeness of sample collection for this project is 95%.

Completeness of usable data is defined as the ratio of all data that is not rejected to the total number of data points. The goal for usable data is also 95%. Completeness of quality data is defined as the ratio of all data that is not qualified to the total number of data points. The goal for quality data is 80%. The formula for calculating completeness is given in Section 2.4.3.

- **Representativeness** - Representativeness qualitatively expresses the extent to which sample data accurately and precisely represents the characteristics of a population of samples, parameter variations at a sampling point, or an environmental condition. Representativeness is most concerned with the proper design of the sampling program and use of appropriate sample collection methods. Representativeness will be evaluated using the field duplicates, equipment blanks, trip blanks, method blanks, and laboratory duplicate results as shown in the SOPs. The examination of field duplicate and equipment blank results will provide a measure of assurance that the samples collected are representative of the sampling points. Trip blanks will be used to assess the effects of shipping activities on the VOC investigative samples. Method blanks will be used to determine if cross-contamination has possibly taken place in the laboratory. Holding times and proper preservation of the samples will be evaluated to ensure the sample results will accurately reflect the sampling points. Holding times and proper preservation are shown in Table 3.
- **Comparability** - Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved through the use of standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units. The data results produced during this project must be comparable to past results. It is expected that if the data meets the requirements described in the QAPP, the result will be comparable with past results.
- **Sensitivity** - Sensitivity is based on the minimum detection reported or possible for the analytes. The calculation procedure for the method detection limit (MDL) is given in Section 2.3.2. The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The practical quantitation limit (PQL) is generally 5 to 10 times the MDL for any given analyte as described in the EPA SW-846 guidance. The sample quantitation limit (SQL) is the PQL multiplied by any dilution factor related to the specific sample. If the reported SQL for any analytical result is greater than the PQL from the method SOPs in Appendix A due to causes other than high target analyte concentrations, then corrective actions must be discussed with the URS project QA/QC officer.

1.5 SPECIAL TRAINING REQUIREMENTS/CERTIFICATIONS

No special training requirements or certifications are required for work activities addressed in the QAPP. United States Army Corps of Engineers (USACE) Laboratory certification is required. All field activities will be performed under the direction of an experienced field team leader. The field team leader will normally be either an engineer, geologist or environmental scientist. A qualified chemist will perform the data review.

1.6 DOCUMENTATION, RECORDS AND DATA REPORTING

If at any time the QAPP is modified, the revised portions of the QAPP will be distributed by URS to personnel on the distribution list.

Information that will be included in data reports generated from sample collection activities defined within this QAPP includes both field collection records and laboratory records.

Sample collection sheets will be completed for primary, as well as QA/QC, samples and will note the method of collection, general field procedures used for sample collection, and any corrective actions taken where approved field methods deviated from the SAP.

The analytical laboratory will provide all project data in both hardcopy and electronic, SMPro compatible format. The format requirements are shown in Appendix B. The laboratory will also be required to confirm sample receipt and log-in information. The laboratory will return a copy of the completed COC, cooler receipt form and confirmation of the laboratory's analytical log-in to URS within 24 hours of sample receipt.

For all (100%) project data, the subcontract analytical laboratory will prepare and deliver a full copy of an analytical data package as required for a Contract Laboratory Program (CLP) Level III like data package. At a minimum, the following information will be provided in each analytical data package submitted:

- Title sheet with project name, contract number, laboratory name and address, point of contact, phone/fax number, and signature of responsible party;
- Case narrative with number and description of samples, tests performed, problems encountered, corrective actions, and general comments; a table summarizing sample identifications (IDs), laboratory IDs, batch numbers, and associated QC samples is desired but optional;
- Summary forms showing surrogate percent recoveries (%Rs) (if required by method), MS/MSD results (if required by method), LCS results (if required by method), method blanks showing associated samples and dates, times of analysis, serial dilution results (if required by method), interference check results (if required by method), QC samples out-of-control along with corrective actions, and calibration check summaries;
- Analytical data arranged by analytical method and by sample ID within each method type which show sample results indicating SQLs;
- QC data results forms showing control limits
- Completed COC records.

Additionally, upon review of the Level III data deliverables, the CENWK Environmental Chemist will randomly select 10% of the data packages for Level IV validation as described below. The analytical laboratory will provide a CLP Level IV like data package for the specified results. The Level IV package will include all Level III information in addition to the following:

- Associated raw data to support the tabulated results for samples and QA/QC
- Tabulation of instrument detection limits determined in pure water.

The lab is required to retain a full copy of the analytical and QC documentation. Such retained documentation will include all hard copies and electronic storage media (e.g., magnetic tape). As needed, the analytical laboratory will supply hard or electronic copies of the retained information.

The data are required to be formatted in a database format, as specified by URS. to facilitate electronic data entry. The electronic data set will be transferred automatically into the project database.

The data set will be validated to an equivalent EPA Level III validation review by the Project QA/QC Officer or their designee. Flags signifying the usability of data will be noted and entered into an analytical database. The associated data flags will include such items as: (1) estimated concentration below-required reporting limit; (2) estimated concentration due to poor calibration, internal standard, or surrogate recoveries; (3) estimated concentration due to poor spike recovery; and (4) estimated concentration of chemical that was also determined in the laboratory blank. The EPA Level III validation review will apply to 100% of project data.

After the validation review has been performed, an EPA Level IV validation on a minimum of 10% of the data, selected by the CENWK Environmental Chemist, will be performed by the Project QA/QC Officer or their designee. Flags, as described above, will be noted and entered into an analytical data base. Deficiencies in data deliverables will be corrected through direct communication with the laboratory, generating immediate response and resolution. All significant data discrepancies noted during the validation process will be documented through Non-conformance Reports (NCRs), which are sent to the laboratory for clarification and correction. Decisions to repeat sample collection and analyses may be made by the Project Manager and the Project QA/QC Officer based on the extent of the deficiencies and their importance in the overall context of the project.

Data assessment will be accomplished by the joint efforts of the data reviewer/validator, the Project QA/QC Officer and the Project Manager. Data assessment will be based on the criteria that the sample was properly collected and handled according to the FSP and QAPP. An evaluation of data precision, accuracy, representativeness, completeness, comparability and sensitivity. based on criteria presented in this QAPP, will be performed by the data validator/reviewer and presented in the Quality Control Summary Report (QCSR). This data quality assessment will indicate that data are: (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to excessive out-of-control QC results.

Project data sets will be available for controlled access by the Database Manager and other authorized personnel. Each data set will be incorporated into project reports as required.

2.1 SAMPLING PROCESS DESIGN AND SAMPLING METHODS REQUIREMENTS

The following sample types will be periodically collected as part of the sampling activities:

- Soil samples from split spoon or Geoprobe™ Macro-Core Soil Sampler
- Surface soil samples
- Concrete borings
- Water samples
- Sediment samples
- Wipe samples
- ACM
- Air samples

The collection procedures for each sample type are presented in the FSP.

The container, preservation, and holding time requirements to be used are shown in Table 3. The COC form, completed at the time of sample packing, will include the sample ID, date and time of sampling, parameters to be analyzed for, and the name of the sampler(s). The COC will be signed, timed and dated by the sample manager when transferring the samples. The samples and completed COC forms will be placed into coolers. The coolers will then be sealed and shipped to the contracted laboratory.

2.2 ANALYTICAL METHODS REQUIREMENTS

Samples collected during the SLAAP sampling effort will be analyzed by the subcontract laboratory. This laboratory must be certified by the USACE Hazardous, Toxic and Radioactive Waste Center of Expertise (HTRW CX). QA samples shall be collected and analyzed by the designated CENWK QA Laboratory.

The subcontract laboratory supporting this work will provide statements of qualifications including organizational structure, QA Manual, and standard operating procedures (SOPs). Laboratory standard operating procedures are based on the methods as published by the EPA in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW846*, Third/Fourth Edition (November 1986; Revision 1, July 1992; Revision 2, November 1992; and Updates 1, 2, and 3) and "Methods and Guidance for Analysis of Water" (EPA 821-C-97-001, April 1997). These SOPs must be adapted from and reference standard SW-846 and EPA methods and thereby specify:

- Procedures for sample preparation
- Instrument start-up and performance check
- Procedures to establish the actual and required detection limits for each parameter
- Initial and continuing calibration check requirements
- Specific methods for each sample matrix type

- Required analyses and QC requirements

Samples collected during the project will be analyzed by SW-846 and EPA methods. The analytes of interest and the corresponding SW-846 and EPA methods to be used for this project are presented in Table 3. The primary SW-846 and EPA methods include:

- VOCs using EPA SW-846 Method 8260B
- SVOCs using EPA SW-846 Method 8270C
- PAHs using EPA SW-846 Method 8310
- Explosives using EPA SW-846 Method 8330
- Pesticides using EPA SW-846 Method 8081A
- PCBs using EPA SW-846 Method 8082
- Total Metals using EPA SW-846 Method 6010B
- Hexavalent Chromium using EPA SW-846 Method 7196
- Mercury using EPA SW-846 Method 7470A/7471A
- TPH-GRO and TPH-DRO using modified EPA SW-846 Method 8015B
- Phosphorus using EPA Method 365.4
- Nitrate using EPA Method 300.0

Table 2 presents the reporting limits for each of the primary analytical methods. The subcontract laboratory will submit SOPs detailing the specific MDLs for each analytical method.

If contaminant concentrations are high, or if matrices (other than normal waters and soils) create a problematic effect on the analysis, analytical protocols may require modifications to defined methodology. Any proposed changes to standard analytical methods require written approval from URS and CENWK. All analytical method variations will be identified in project addenda. These may be submitted for regulatory review and approval when directed by the CENWK Project Manager.

2.3 QUALITY CONTROL REQUIREMENTS

Quality assurance/quality control (QA/QC) samples are analyzed for the purpose of assessing the quality of the sampling effort and of the reported analytical data. QA/QC samples to be used for the SLAAP project include field duplicate samples, CENWK, EPA and MDNR split samples, equipment rinsate blanks, trip blanks, method blanks, laboratory control samples, laboratory duplicate samples, and matrix spike and matrix spike duplicate samples. The list of QC criteria, their acceptance limits, and the required corrective actions are given in Table 1.

2.4 CALCULATION OF DATA QUALITY INDICATORS

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, representativeness, comparability and sensitivity as outlined in the following sections.

2.4.1 Precision

Precision will be evaluated using the RPD between replicate analyses of LCS/LCSD, MS/MSD, replicate field samples spiked identically by the laboratory, field duplicates and laboratory duplicates. Precision determined using RPD will be calculated as follows:

$$RPD = \left(\frac{|X_1 - X_2|}{(X_1 + X_2)/2} \right) x100\%$$

where

X_1 = analyte concentration in the sample

X_2 = analyte concentration in the duplicate

2.4.2 Accuracy

Analytical accuracy will be evaluated using the %R results of the LCS/LCSDs, MS/MSDs and surrogate recoveries (if required by the method). Accuracy as determined by the %R will be calculated as follows:

$$\%R = \left(\frac{(Xs - Xu)}{K} \right) x100\%$$

where

X_S = Measured Value of Spiked Sample

X_U = Measured Value of Unspiked Sample

K = Known Amount of the Spike in the Sample

2.4.3 Completeness

Completeness will be calculated using the following formula:

$$\%C = \left(\frac{V}{N} \right) \times 100\%$$

where

V = Number of Measurements

(i.e. for sample collection, V = number of samples actually taken; for usable data, V = data points not rejected; for quality data, V = data points not qualified)

N = Number of Total Measurements

2.4.4 Sensitivity

Method Detection Limit (MDL) values must be calculated from data obtained from an MDL study. The MDL study will follow the procedures in Appendix A of 40 CFR 136. MDL is defined as follows:

$$MDL = t\left(_{n-1,1-\alpha=0.99}\right)(S)$$

where

$t\left(_{n-1,1-\alpha=0.99}\right)$ = Student's t-value appropriate for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom

S = Standard deviation of the replicate analyses (minimum of 7 replicate analyses are recommended)

2.5 INSTRUMENT CALIBRATION AND FREQUENCY

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment that are used for conducting analyses. These instruments and equipment shall be calibrated before each use or on a scheduled, periodic basis according to manufacturer instructions and/or the appropriate analytical methods.

2.5.1 Field Instrumentation

All field instrumentation will be calibrated or the calibration will be checked at least daily against a known standard prior to the commencement of use. The calibration will be performed in accordance with the manufacturer's instructions and recorded in the field log book.

2.5.2 Laboratory Instrumentation

Details regarding the procedures for calibration of laboratory equipment and maintenance of calibration records will be presented in laboratory QA Plans and/or SOPs. These procedures will be reviewed by URS and CENWK prior to the start of sampling and analysis activities. For all analyses conducted according to SW-846 and EPA methods, the calibration procedures and frequencies specified in the methods will be followed.

Records of calibration will be kept as follows:

- Each instrument will have a record of calibration with an assigned record number.
- A label will be affixed to each instrument showing identification numbers, manufacturer, model numbers, date of last calibration, signature of calibrating analyst, and due date of next calibration. Reports and compensation or correction figures will be maintained with instrument.
- A written step-wise calibration procedure will be available for each piece of test and measurement equipment.

- Any instrument that is not calibrated to the manufacturer's original specification will display a warning tag to alert the analyst that the device carries only a "Limited Calibration."

Records of calibration, repairs, or replacement will be filed and maintained by laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit.

2.6 FIELD INSTRUMENT TESTING, INSPECTION, AND MAINTENANCE

Field instruments that will be used during sample collection activities include a hand held photo ionization detector (PID), a multi-gas meter, a dust monitor and water quality parameter measurement equipment. Prior to mobilization, the URS QA/QC officer or his or her designee, or the equipment vendor will test each instrument if using rental equipment, to assure that the instruments are in working order.

Prior to use, field personnel will test and inspect the instruments during daily calibration to confirm that the instruments are in working order. Testing and inspection will be performed a minimum of once daily. If an instrument is found to be working incorrectly, field maintenance will be performed according to the manufacturers or vendors written and/or verbal instructions. If the instrument cannot be repaired, it will be returned to the manufacturer or vendor for repair and a replacement instrument obtained. Calibration of the field equipment shall be recorded in the field logbook.

2.7 SUPPLIES AND CONSUMABLES

Supplies and consumables that will be used during sample collection include:

- Sample containers
- Wipe sample templates
- Calibration standards
- Deionized water
- Disposable bailers

To assure that supplies and consumables are acceptable for use, documentation certifying the cleanliness of the sample containers, deionized water, and disposable bailers will be provided by the vendor. In addition, calibrations standards for the PID and water quality parameter measurement instruments will be inspected to make sure that expiration dates have not been exceeded.

3.1 ASSESSMENT AND RESPONSE ACTIONS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FSP and QAPP. Audits of laboratory activities will include both internal and external audits.

3.1.1 External Laboratory Audits

The USACE HTRW CX conducts on-site audits and validates laboratories on a regular basis. These USACE independent on-site systems audits in conjunction with performance evaluation samples (performance audits) qualify laboratories to perform USACE environmental analysis every 18 months.

These system audits include examining laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, etc. Performance audits consist of sending performance evaluation samples to USACE laboratories for on-going assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated by USACE HTRW CX to ensure that laboratories maintain an acceptable performance.

3.1.2 Internal Laboratory Audits

Internal performance and system audits of laboratories will be conducted by the Laboratory QA Officer as directed in the laboratory QA Plans. These system audits will include examination of laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, etc. Internal performance audits are also conducted on a regular basis. Single-blind performance samples are prepared and submitted along with project samples to the laboratory for analysis. The Laboratory QA Officer will evaluate the analytical results of these single-blind performance samples to ensure that the laboratory maintains acceptable performance.

3.2 REPORTS TO MANAGEMENT

The Project Manager will report to CENWK on the progress of the work and any problems encountered during the project.

3.2.1 Daily Quality Control Reports

During field activities, URS will prepare Daily Quality Control Reports (DQCRs) as described in the FSP. In addition to the item specified in the FSP, a daily analytical data report will be included as an attachment to the DQCR. This report will present tabulated analytical results for data that was received since the prior DQCR was submitted to USACE.

3.2.2 Laboratory Quality Assurance Reports

Each laboratory will provide Letters of Receipt (LORs) and analytical QC summary statements (case narratives) with each data package. All COC forms will be compared with samples

received by the laboratory and an LOR will be prepared and sent to URS describing any differences in the COC forms and the sample labels or tags. All deviations will be identified on the receiving report, such as broken or otherwise damaged containers. This report will be forwarded to URS within 24 hours of sample receipt and will include the following: a signed copy of the COC form; signed, completed copy of the cooler receipt form: itemized sample numbers; laboratory sample numbers; cooler temperature upon receipt; and itemization of analyses to be performed. Summary QC statements will accompany analytical results as they are reported by the laboratory in the form of case narratives for each sample delivery group.

3.2.3 Quality Control Summary Reports

At the conclusion of field investigation activities and laboratory analysis, URS, in addition to any review conducted by the laboratory, will perform its own review/validation of the submitted data. This activity will include assignment of flags to data, documentation of the reason(s) for the assignments, and description of any other data discrepancies. URS will then prepare a QCSR, which will be included as an appendix to the final report. This report will be submitted to the CENWK Project Manager as determined by the project schedule. The contents of the QCSR will include data review/validation documentation and discussion of all data that may have been compromised or influenced by aberrations in the sampling and analytical processes. Both field and laboratory QC activities will be summarized, and all DQCR information will be consolidated. Problems encountered, corrective actions taken, and their impact on project DQOs will be determined.

The following are examples of elements to be included in the QCSR, as appropriate:

- Laboratory QC evaluation and summary of the data quality for each analytical type and matrix. Part of the accuracy, precision, and sensitivity summarized in the data quality assessment.
- Field QC evaluation and summary of data quality relative to data usability. Part of the accuracy, precision, and sensitivity summarized in the data quality assessment.
- Overall data assessment and usability evaluation.
- DQCR consolidation and summary.
- Summary of lessons learned during project implementation.

Specific elements to be evaluated within the QCSR include the following:

- Sample results
- Field and laboratory blank results
- Laboratory control sample percent recovery (method dependent)
- Sample matrix spike percent recovery (method dependent)
- Matrix spike/matrix spike duplicate or sample duplicate RPD (method dependent)
- Analytical holding times
- Surrogate recovery, when appropriate.

3.2.4 Field Work Variances

Any departures from approved plans will receive prior approval from the CENWK Project Manager and will be addressed in a manner consistent with the procedures discussed in Section 9.0 of the FSP.

3.2.5 Project Evidence Files

URS will maintain custody of the project evidence file and will maintain the contents of files for this project, including all relevant records, reports, logs, field logbooks, pictures, subcontractor reports, correspondence, and COC forms, until this information is transferred to the CENWK Project Manager. These files will be stored under custody of the Project Manager. The analytical laboratory will retain all original analytical raw data information (both hard copy and electronic) in a secure, limited access area and under custody of the laboratory Project Manager.

Data will be evaluated to determine the usability of the data and if the data provides the information necessary to meet the DQOs defined in Section 1.4. The Project Manager will make these determinations based on recommendations from the Project QA/QC Officer or their designee. The Project QA/QC Officer, or their designee, will review all laboratory data in order to evaluate if the data meets the requirements set out in the laboratory SOPs (Appendix A) and the DQOs.

4.1 DATA REVIEW/VERIFICATION

All data generated by the analytical laboratory will be initially reviewed by the laboratory technical personnel prior to being submitted to URS. This review will provide a check to ensure the correctness of the reported results and generate a case narrative to explain any anomalies which may affect the validity or usability of the data. Following receipt of the data package, the data will be validated by the Project QA/QC Officer or their designee.

4.1.1 Field Data

Raw data from field measurements and sample collection activities will be appropriately recorded in field logbooks or on field data sheets. Data to be used in project reports will be reduced and summarized. The methods of data reduction will be documented.

The Project Manager or designee is responsible for data review of all field-generated data. This includes verifying that all field descriptive data are recorded properly, that all field instrument calibration requirements have been met, that all field QC data have met frequency and criteria goals, and that field data are entered accurately in all logbooks and worksheets.

4.1.2 Laboratory Data

All samples collected for the project will be sent to a USACE-certified laboratory. Data reduction, evaluation, and reporting of samples analyzed by the laboratory will be performed according to specifications outlined in both the laboratory's QA Plans and this QAPP. Laboratory reports will include documentation verifying analytical holding time compliance.

The laboratory will perform in-house analytical data reduction under the direction of the Laboratory QA Manager. The Laboratory QA Manager or designee are ultimately responsible for assessing data quality and informing URS and CENWK of any data which are considered "unacceptable" or require caution on the part of the data user in terms of its reliability. Data will be reduced, reviewed, and reported as described in the laboratory QA Plans. Data reduction, review, and reporting activities performed by the laboratory are summarized below:

- Raw data are produced by the analyst who has primary responsibility for the accuracy and completeness of the data. All data will be generated and reduced following the QAPP defined methods and implementing laboratory SOP protocols.
- Level I technical data review is completed relative to an established set of guidelines by a peer analyst. The review shall ensure the completeness and correctness of the data while assuring all method QC measures have been implemented and were within appropriate criteria. Items to be reviewed include: preparation logs, analysis runs, methodology, results quality control results, internal QC checks, checklists and sign off sheets.

- Level 2 technical review is completed by the area supervisor or data review specialist. This reviews the data for attainment of QC criteria as outlined in the established methods and for overall reasonableness. It will ensure all calibration and QC data are in compliance, qualitative identification of compounds is correct, quantitative calculations are correct, and check at least 10 percent of the data calculations. This review shall document that the data package is complete and ready for reporting and archival.
- Upon acceptance of the raw data by the area supervisor, the report is generated and sent to the Laboratory Project Manager or QA representative for Level 3 administrative data review. This overview will ensure consistency and compliance with all laboratory instructions, the laboratory QA Plans, the project laboratory SOW, and the project QAPP.
- The Laboratory Project Manager will complete a thorough review of all reports.
- Final reports will be generated and signed by the Laboratory Project Manager.
- Data packages, in CLP like format, will then be delivered to URS for data validation (refer to Table 4).

The data review process will include identification of any out-of-control data points and data omissions, as well as interactions with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. The laboratory will provide flagged data to include such items as:

- Concentration below required detection limit
- Estimated concentration due to sample analyte recovery exceeding calibration range
- Concentration of chemical also found in laboratory blank

4.1.3 Contractor Review/Validation

The analytical data validation will be performed only to the level necessary to minimize the potential of using false positive or false negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected compounds). This approach is consistent with the DQOs for the project, with the analytical methods, and for determining contaminants of concern and calculating risk.

Samples will be analyzed through use of standard analytical methods. Data will be reported consistent with the deliverables identified in Section 1.6 and 4.1.2 . This report content is consistent with what is understood as an EPA Level IV deliverable (data forms including laboratory QC, and raw sample data including calibration information). Definitive data will then be validated and qualified using guidelines established by the analytical method. DQOs identified in Section 1.4 and method-specified criteria will be validated. An additional copy of the comprehensive analytical information will be retained by the subcontract laboratory.

Validation will be performed by comparing the contents of the complete data package (raw data, sample results and QA/QC results) to the requirements established both in the requested analytical methods and the criteria presented in this QAPP. The Project QA/QC Officer will be responsible for these activities. The protocols for analytical data validation are presented in:

- SW-846 Analytical Method Requirements
- EPA CLP National Functional Guidelines for Organic Data Review (EPA 1999)
- EPA CLP National Functional Guidelines for Inorganic Data Review (EPA 1994)
- CENWK-PE-ES Data Quality Evaluation Guidance (August 1998)

The data will be validated using the processes and procedures provided in the National Functional Guidelines and CENWK-PE-ES Data Quality Evaluation Guidance, but the guidelines used for control will be the historical laboratory established limits

4.2 ANALYTICAL CORRECTIVE ACTIONS

Corrective actions may be required for two major types of problems: analytical/equipment problems and noncompliance with acceptance criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

The laboratory-specific QA Plan shall provide systematic procedures to identify laboratory related out-of-control situations and corrective actions. Corrective actions shall be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel will have received QA training and will be aware that corrective actions are necessary when:

- QC data are outside warning or control windows for precision and accuracy
- Blanks contain target analytes above acceptable levels and must be investigated
- Undesirable trends are detected in spike recoveries or RPD between duplicates
- There are unusual changes in detection limits
- Deficiencies are detected by internal audits, external audits, or from performance evaluation samples results
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, prepares spike and calibration mixes, checks instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with project records and the QA Department, and the information is summarized within case narratives.

Typical analytical corrective actions include:

- Re-analyzing the samples, if holding time criteria permit
- Re-extraction and re-analysis, if holding time criteria permit
- Evaluating blank contaminant sources, elimination of these sources, and reanalysis
- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation

- Re-sampling and analyzing
- Evaluating and amending sampling procedures
- Accepting data and acknowledging the level of uncertainty.

If re-sampling is deemed necessary due to laboratory problems, the URS and CENWK Project Managers will evaluate the costs/benefits of implementing the additional sampling effort.

ASTM (American Society of Testing and Materials). 1996. Annual Book of ASTM Standards, Volume 04.08, Soil and Rock.

EPA (U. S. Environmental Protection Agency) 1985. NEIC Policies and Procedures, EPA-300/9-78DDI-R, Revised June.

EPA 1991. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QA/R5, revised October

EPA 1994a. Guidance for the Data Quality Objectives Process, QA/G-4, September.

EPA 1996. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, Final Update III.

EPA 2001. EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, March.

EPA 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-99/008, October.

EPA 1994b.USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94/013, February.

CENWK-PE-ES Data Quality Evaluation Guidance (August 1998)

USACE (U. S. Army Corps of Engineers) 1994. Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3, September.

USACE (U. S. Army Corps of Engineers) 1998. Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities, ER 1110-1-263, April.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
300.0/ Nitrate	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected	RPD < 20%	Qualify data according to CENWK guidance.
	Rinsate	1 for every 10 field samples collected	≤ detection limit	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Calibration	At start of analysis	Coefficient of correlation must be > 0.995	1. Check standard solution 2. Re-prepare standard
	Calibration stability	Every 10 samples and at end of analysis	± 1 mg/L	1. Check standard solution 2. Re-calibrate and re-analyze samples
	Method blank	1 per analytical batch; batch = maximum of 20 samples	≤ detection limit	1. Check blank 2. Qualify data according to CENWK guidance.
	MS	To a minimum of 10% of routine samples	If concentration of fortification is < 25% of background in sample, do not calculate, otherwise 90-110% recovery	Check laboratory performance. If in control, matrix interference should be suspected.
	LCS	1 per analytical batch; batch = maximum of 20 samples	90-110% recovery	Determine cause (if possible), correct and re-analyze. Discontinue analysis until problem is solved.
	Duplicate	1 per analytical batch; batch = maximum of 20 samples	RPD < 20%	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, Qualify data according to CENWK guidance.
365.4/ Phosphorus	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected	RPD < 20%	Qualify data according to CENWK guidance.
	Rinsate	1 for every 10 field samples collected	≤ detection limit	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Method blank	1 per analytical batch; batch = maximum of 20 samples	≤ detection limit	1. Check blank 2. Qualify data according to CENWK guidance.
	Duplicate	1 per analytical batch; batch = maximum of 20 samples	RPD < 20%	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, Qualify data according to CENWK guidance.
6010B/Total metals	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<30% soil/waste RPD<40%	Review lab QC data to determine if they are in control. If not in control, qualify data according to CENWK guidance Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
6010B/Total metals (continued)	Rinsate	1 for every 10 field samples collected	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial (ICV) and continuing (CCV) calibration verification	ICV – prior to sample analysis and re-analysis of high standard CCV – after every 10 samples and end of analytical batch	ICV – 4 pt. calibration (3 stds and a blank); high standard within 5% of true value. CCV – midpoint range standard within 10% of true value.	Terminate analysis, solve problem, re-calibrate and re-analyze samples analyzed since last good CCV.
	High mixed calibration standard	Before beginning of sample run	Agree within 10% of expected value	Follow recommendation of instrument manufacturer.
	Continuing (CCB) calibration blank	After every 10 samples and end of analytical batch	Detections of analytes < required SQLs	Terminate analysis, solve problem, recalibrate and re-analyze samples analyzed since last good CCB.
	Method blank	1 per analytical batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Re-digest and re-analyze all samples greater than the SQL but less than 10x the blank concentration.
	Serial dilution	1 per sample digestion batch	1:5 dilution agree within ± 10% of original determination	Flag as chemical or physical interference.
	MS/MSD	1 per analytical batch; batch = maximum of 20 samples	75 – 125% recovery (unless sample is greater than 4x spike concentration). Minimum 10x detection limit.	Determine cause (if possible), correct and re-spike. If cause cannot be determined, qualify data according to CENWK guidance.
	LCS	1 per analytical batch; batch = maximum of 20 samples	80-120% recovery for all analytes	Re-digest and re-analyze all samples for out of control analyte. If problem cannot be corrected, qualify data according to CENWK guidance.
	Duplicate	1 per batch of samples, minimum 1 per 20 samples	20% RPD for samples greater than 5x SQL; if 5x SQL, absolute difference between samples must be < SQL; no criteria if < SQL	Determine cause (if possible), correct and re-spike. If cause cannot be determined, qualify data according to CENWK guidance.
	Interference check	Beginning and end of run or per 8 hour shift	80 – 120% recovery for all analytes	Terminate analysis, solve problem, re-calibrate and re-analyze samples analyzed since last good ICS.
7196/Hexavalent chromium	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, %RPD must be less than current control limits: Aqueous samples – RPD <30% Non-aqueous samples – RPD <40%	Review lab QC data to determine if they are in control. If not in control, qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
7196/Hexavalent chromium (continued)	Rinsate	1 for every 10 field samples collected	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Method blank	1 for every 10 samples or extraction batch	Less than reporting detection limit	Document and report to client.
	MS/MSD	1 for every 10 samples	See SOP	Document and report to client.
	Continuing calibration	1 for every 15 samples	See SOP	Terminate analysis, solve problem, re-calibrate and re-analyze samples analyzed since last good continuing calibration.
	LCS/LCSD	1 for every 10 samples	80 – 120% recovery, RPD ≤ 20%	Terminate analysis, solve problem.
	Duplicate	1 for every 10 samples	Above 10x detection limit, %RPD must be less than the control limits: Aqueous samples – RPD ≤30% Non-aqueous samples – RPD ≤40%	Determine cause (if possible), correct and re-spike. If cause cannot be determined, qualify data according to CENWK guidance.
7470A/7471A/ Mercury	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, %RPD must be less than current control limits: Aqueous samples – RPD <20% Non-aqueous samples – RPD <35%	Review lab QC data to determine if they are in control. If not in control, qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected	Less than reported detection limits	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	ICV/CCV	ICV – prior to sample analysis CCV – after every 10 samples or end of analytical batch, whichever is more frequent	ICV – 4 pt. calibration (3 stds and a blank); verification measured value within 10% of true value using 1 blank and 1 mid-range. If samples > 10, CCV within 20% of true.	Terminate analysis, solve problem, re-calibrate and re-analyze samples analyzed since last good CCV.
	ICB/CCB	ICB – after initial calibration CCB – after every 10 samples or end of analytical batch, whichever is more frequent	Absolute value < SQL	Terminate analysis, solve problem, re-calibrate and re-analyze samples analyzed since last good CCB.
	Method blank	1 per analytical batch; batch = maximum of 20 samples	Absolute value < SQL	Re-digest and re-analyze all samples less than 10x the SQL.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
7470A/7471A/ Mercury (continued)	Matrix spike	1 per analytical batch; batch = maximum of 20 samples	75 – 125% recovery (unless sample concentration is greater than 4x spike concentration). Spike 5x above background at minimum.	Determine cause, then re-spike. If uncorrectable, correct for bias if recovery is < 80%.
	Matrix spike duplicate	1 per analytical batch; batch = maximum of 20 samples	Aqueous samples – RPD = 25% Non-aqueous samples – RPD = 35%	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, qualify data according to CENWK guidance.
	LCS	1 per analytical batch; batch = maximum of 20 samples	water - 75 – 125% recovery soil/waste – manufacturer's limits	Re-run. If still out of control, solve problem and re-analyze batch.
	Serial dilution	1 per analytical batch; batch = maximum of 20 samples	Diluted values must be < 10% of the original value	Perform recovery test.
	Recovery test	When results from dilution test fail. Test is run on the failed sample.	85 – 115% recovery	Run method of standard additions (MSA)
	MSA	When matrix interference is suspected or when recovery test fails	slope within 20% of standard curve	Qualify all associated data according to CENWK guidance.
Modified 8015/ TPH-DRO	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<20% soil/waste RPD<35%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; RSD of mean ≤ 20%	Correct problem. Recalibrate instrument. Reject if problem not solved.
	Continuing calibration	Every 12 hours of operation	Response factor %D ≤ 15% from average of initial calibration.	Correct problem and rerun continuing calibration. If still out of control, recalibrate instrument. Reanalyze samples. Reject if problem not solved.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Reanalyze blank, then re-extract if necessary. If contamination still exists, qualify all associated data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Modified 8015/ TPH-DRO (continued)	Surrogate	Every sample	See SOP	1. Check calculations and instrument performance 2. If problem found, correct and recalculate and/or re-analyze extract. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance.
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Run LCS. If LCS is good, and assignable cause is found for poor MS/MSD, correct and redo MS/MSD. Otherwise, qualify data according to CENWK guidance.
	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Re-extract entire sample batch and associated QC and rerun.
Modified 8015/ TPH-GRO	***FIELD QC:***			
	Trip Blank	1 for each cooler of samples shipped to each laboratory only if the cooler contains VOC samples	Detections of analytes < required SQLs	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<30% soil/waste RPD<40%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; RSD of mean ≤ 20%	Recalibrate instrument.
	Continuing calibration	Every 12 hours of operation	Response factor %D ≤ 15% from average of initial calibration.	Rerun continuing calibration. If still out of control, recalibrate instrument.
	Method Blank	1 per analytical batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Reanalyze blank. If contamination still exists, qualify all associated data according to CENWK guidance.
	Storage Blank	Minimum of 1 per sampling event	Detections of analytes < required SQLs	Reanalyze blank. If contamination still exists, qualify all associated data according to CENWK guidance.
	Surrogate recovery	Every sample	See SOP	1. Check for errors during analysis. If found, recalculate. 2. Check instrument performance. Correct problem and reanalyze. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Modified 8015/ TPH-GRO (continued)	MS/MSD	1 per analytical batch; batch = maximum of 20 samples	See SOP	Analyze LCS. If more than 30% of either MS or MSD is outside tolerance, perform corrective actions as detailed above.
	LCS	1 per analytical batch; batch = maximum of 20 samples	See SOP	Reanalyze LCS. If out, correct problem. If problem cannot be corrected, reject data.
8081A/Pesticides	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected 5% for wipe samples	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<30% soil/waste RPD<35%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	Field blanks	2 from each category (wipe samples only)	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; the average response factor can be used if %RSD is ≤ 20% or use a calibration curve	Re-calibrate instrument.
	Continuing calibration	Daily and after every 10 samples	Response factor ≤ 15% difference from midpoint standard	Re-run continuing calibration. If still out of control, re-calibrate instrument.
	Endrin and DDT breakdown	Each initial calibration	Must not exceed 20%	Re-analyze breakdown standard. If still out of control, clean injection port, change septae, trim first few inches off column.
	Combined Endrin and DDT breakdown	Each initial calibration	Must not exceed 30%	Re-analyze breakdown standard. If still out of control, clean injection port, change septae, trim first few inches off column.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Re-analyze blank. If second blank exceeds criteria, clean analytical system. Qualify the data according to CENWK guidance.
	Surrogate recovery	Every sample	See SOP	Re-run sample. If still out of control, re-extract, re-analyze, qualify data according to CENWK guidance.
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, qualify data according to CENWK guidance.
	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, qualify data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
8081A/Pesticides (continued)	Confirmation Analysis	Performed for all samples with at least one analyte detected above its MDL during the primary column analysis	Confirmation analysis performed on dissimilar column at a dilution factor approximately the same as for the primary column analysis; RPD between columns <40%; Report highest result	Flag detections with confirmation RPD >40%, reject unconfirmed explosives detections.
8082/PCBs	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected 5% for wipe samples	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise water RPD<30% soil/waste RPD<35%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	Field blanks	2 from each category (wipe samples only)	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; the average response factor can be used if %RSD is ≤ 20% or use a calibration curve	Re-calibrate instrument.
	Continuing calibration	Daily and after every 10 samples	Response factor ≤ 15% difference from midpoint standard	Re-run continuing calibration. If still out of control, re-calibrate instrument.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Re-analyze blank. If second blank exceeds criteria, clean analytical system. Qualify the data according to CENWK guidance.
	Surrogate recovery	*Every sample*	See SOP	*Re-run sample. If still out of control, re-extract, re-analyze, qualify data* according to CENWK guidance.
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, qualify data according to CENWK guidance.
	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Determine cause (if possible), correct and re-analyze. If cause cannot be determined, qualify data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
8082/PCBs (continued)	Confirmation Analysis	Performed for all samples with at least one analyte detected above its MDL during the primary column analysis	Confirmation analysis performed on dissimilar column at a dilution factor approximately the same as for the primary column analysis; RPD between columns <40%; Report highest result	Flag detections with confirmation RPD >40%, reject unconfirmed explosives detections.
8260B/VOCs	***FIELD QC:***			
	Trip Blank	1 for each cooler of samples shipped to each laboratory only if the cooler contains VOC samples	Detections of analytes < required SQLs	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<30% soil/waste RPD<40%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Instrument Tune	At beginning of analytical sequence(i.e., prior to initial calibration) and every 12 hours of operation thereafter	Ion abundance criteria; see method	Tune instrument; repeat.
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration: SPCCs ≥0.300; 1,1,2,2-TCA ≥0.200, bromoform ≥0.100. RSD<30% for RF for CCCs	Recalibrate instrument.
	Continuing calibration	Every 12 hours of operation	SPCCs ≥0.300, except 1,1,2,2-TCA ≥0.200 and bromoform ≥0.100. RSD <25% for average RF for CCCs	Rerun continuing calibration. If still out of control, recalibrate instrument.
	Method Blank	1 per analytical batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Reanalyze blank. If contamination still exists, qualify all associated data according to CENWK guidance.
	Storage Blank	Minimum of 1 per sampling event	Detections of analytes < required SQLs	Reanalyze blank. If contamination still exists, qualify all associated data according to CENWK guidance.
	Surrogate recovery	Every sample	See SOP	1. Check for errors during analysis. If found, recalculate. 2. Check instrument performance. Correct problem and reanalyze. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
8260B/VOCs (continued)	MS/MSD	1 per analytical batch; batch = maximum of 20 samples	See SOP	Analyze LCS. If more than 30% of either MS or MSD is outside tolerance, perform corrective actions as detailed above.
	LCS	1 per analytical batch; batch = maximum of 20 samples	See SOP	Reanalyze LCS. If out, correct problem. If problem cannot be corrected, reject data.
8270C/SVOCs	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<20% soil/waste RPD<35%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Sensitivity check	At beginning of each 12 hour period	Ion abundance criteria; see method	Tune instrument; repeat. If cannot be corrected, reject data.
	Mass calibration	Every 24 hours and at beginning of each analytical sequence	See SOP	Tune instrument; repeat.
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; SPCCs >0.050; CCC response factor deviates <30% from average	Correct problem. Recalibrate instrument. Reject if problem not solved.
	Continuing calibration	Every 12 hours of operation	SPCCs ≥0.050; CCCs ≤30% from standard concentration, RT of IS ≤30 sec over 12 hours and EICP area changes within –50% to +100%.	Correct problem and rerun continuing calibration. If still out of control, recalibrate instrument. Reanalyze samples. Reject if problem not solved.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Less than SQL. Phthalate esters less than 5x the reporting limit.	Reanalyze blank, then re-extract if necessary. If contamination still exists, qualify all associated data according to CENWK guidance.
	Surrogate	Every sample	See SOP	1. Check calculations and instrument performance 2. If problem found, correct and recalculate and/or re-analyze extract. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Run LCS. If LCS is good, and assignable cause is found for poor MS/MSD, correct and redo MS/MSD. Otherwise, qualify data according to CENWK guidance.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
8270C/SVOCs (continued)	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Re-extract entire sample batch and associated QC and rerun.
8310/PAHs	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<20% soil/waste RPD<50%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; %RSD must be < 20% for all analytes	Correct problem. Recalibrate instrument. Reject if problem not solved.
	Continuing calibration	Every 12 hours of operation	Response factor must be < 15% from average of initial calibration	Correct problem and rerun continuing calibration. If still out of control, recalibrate instrument. Reanalyze samples. Reject if problem not solved.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Reanalyze blank, then re-extract if necessary. If contamination still exists, qualify all associated data according to CENWK guidance.
	Surrogate	Every sample	See SOP	1. Check calculations and instrument performance 2. If problem found, correct and recalculate and/or re-analyze extract. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance.
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Run LCS. If LCS is good, and assignable cause is found for poor MS/MSD, correct and redo MS/MSD. Otherwise, quality data according to CENWK guidance.
	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Re-extract entire sample batch and associated QC and rerun.
	Confirmation Analysis	Performed for all samples with at least one analyte detected above its MDL during the primary column analysis	Confirmation analysis performed on dissimilar column at a dilution factor approximately the same as for the primary column analysis; RPD between columns <40%. Report highest result	Flag detections with confirmation RPD >40%. reject unconfirmed explosives detections.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

ANALYTICAL METHOD/ PARAMETER	QC CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
8330/Explosives	***FIELD QC:***			
	Duplicate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	If result < 10 times SQL, results must agree within a factor of 2 of each other. Otherwise: water RPD<20% soil/waste RPD<50%	Review lab QC data to determine if they are in control. If not in control, Qualify data according to CENWK guidance. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate	1 for every 10 field samples collected, minimum of 1 per sampling event and sample type	Detections of analytes < required SQLs	Qualify data according to CENWK guidance.
	LABORATORY QC:			
	Initial calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; %RSD must be < 20% for all analytes	Correct problem. Recalibrate instrument. Reject if problem not solved.
	Continuing calibration	Every 12 hours of operation	Response factor must be < 15% from average of initial calibration	Correct problem and rerun continuing calibration. If still out of control, recalibrate instrument. Reanalyze samples. Reject if problem not solved.
	Method blank	1 per extraction batch; batch = maximum of 20 samples	Detections of analytes < required SQLs	Reanalyze blank, then re-extract if necessary. If contamination still exists, qualify all associated data according to CENWK guidance.
	Surrogate	Every sample	See SOP	1. Check calculations and instrument performance 2. If problem found, correct and recalculate and/or re-analyze extract. 3. If no problem found, re-extract and re-analyze sample. If problem persists, qualify data according to CENWK guidance.
	MS/MSD	1 per extraction batch; batch = maximum of 20 samples	See SOP	Run LCS. If LCS is good, and assignable cause is found for poor MS/MSD, correct and redo MS/MSD. Otherwise, qualify data according to CENWK guidance..
	LCS	1 per extraction batch; batch = maximum of 20 samples	See SOP	Re-extract entire sample batch and associated QC and rerun.
	Confirmation Analysis	Performed for all samples with at least one analyte detected above its MDL during the primary column analysis	Confirmation analysis performed on dissimilar column at a dilution factor approximately the same as for the primary column analysis; RPD between columns <40%; Report highest result	Flag detections with confirmation RPD >40%, reject unconfirmed explosives detections.

Table 1
Quality Control Procedures and QC Acceptance Criteria
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Note:

ICB	Initial Calibration Blank
ICS	Interference Check Sample
CCB	Continuing Calibration Blank
ICV	Initial Calibration Verification
CCV	Continuing Calibration Verifica ion
LCS	Laboratory Control Sample
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSA	Method of Standard Additions
PAH	Polynuclear Aromatic Hydrocarbons
SQL	Sample Quantitation Limit
QC	Quality Control
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
%D	Percent Difference

Table 2
Laboratory Reporting Limits
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Reporting Limits		
		Soil (mg/kg)	Water (µg/L)	Air (µg/m³)
EPA 300.0	Nitrate		10,000	
EPA 365.4	Phosphorous	1.6	0.73	
SW-846 6010B (Metals)	Antimony	31	15	0.21
	Arsenic	0.39	0.045	0.00045
	Barium	5,400	2,600	0.52
	Beryllium	150	73	0.0008
	Cadmium	9	18	0.0011
	Chromium (III)	100,000	55,000	
	Copper	2,900	1,400	
	Lead	400	0.0036	
	Nickel	150	730	
	Selenium	390	180	
	Silver	390	180	
	Thallium	5.2	2.4	
	Zinc	23,000	11,000	
SW-846 7196	Chromium (VI)	0.2	0.16	0.000023
SW-846 7471A/7470A	Mercury	6.1	11	0.31
SW-846 8015B (TPH-DRO)	Mineral Spirits			
	Gasoline			
	Jet Fuel			
	Kerosene			
	Diesel Fuel			
	Fuel Oil			
	Motor Oil			
	TPH			
SW-846 8015B (TPH-GRO)	Gasoline			

Table 2
Laboratory Reporting Limits
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Reporting Limits		
		Soil (mg/kg)	Water (µg/L)	Air (µg/m³)
SW-846 8081A (Pesticides)	4,4'-DDD	2.4	0.28	0.028
	4,4'-DDE	1.7	0.2	0.02
	4-4'-DDT	1.7	0.2	0.02
	Aldrin	0.029	0.004	0.00039
	alpha-BHC	0.090	0.011	0.0011
	beta-BHC	0.32	0.037	0.0037
	Chlordane	1.6	0.19	0.019
	delta-BHC	0.090	0.011	0.0011
	Dieldrin	0.03	0.0042	0.00042
	alpha-Endosulfan	370	220	22
	beta-Endosulfan	370	220	22
	Endosulfan Sulfate			
	Endrin	18	11	1.1
	Endrin Aldehyde			
	gamma-BHC	0.44	0.052	0.0052
	Heptachlor	0.11	0.015	0.0015
	Heptachlor Epoxide	0.053	0.0074	0.00074
	Toxaphene	0.44	0.061	0.0060
SW-846 8082 (PCBs)	PCB-1016	3.9	0.034	0.0034
	PCB-1221	0.22	0.96	0.096
	PCB-1232	0.22	0.034	0.0034
	PCB-1242	0.22	0.034	0.0034
	PCB-1248	0.22	0.034	0.0034
	PCB-1254	0.22	0.034	0.0034
	PCB-1260	0.22	0.034	0.0034
	Polychlorinated biphenyls	0.22	0.034	0.0034

Table 2
Laboratory Reporting Limits
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Reporting Limits		
		Soil (mg/kg)	Water (µg/L)	Air (µg/m³)
SW-846 8260B (VOCs)	1,1,1-Trichloroethane	630	540	1,000
	1,1,2,2-Tetrachloroethane	0.38	0.055	0.033
	1,1,2-Trichloroethane	0.84	0.2	0.12
	1,1-Dichloroethane	590	810	520
	1,1-Dichloroethylene	0.054	0.046	0.038
	1,2,4-Trichlorobenzene	650	190	210
	1,2-Dichlorobenzene	370	370	210
	1,2-Dichloroethane	0.35	0.12	0.074
	1,2-Dichloropropane	0.35	0.16	0.099
	1,3-Dichlorobenzene	13	5.5	3.3
	1,4-Dichlorobenzene	3.4	0.5	0.31
	2-Chloroethylvinyl Ether			
	Benzene	0.65	0.35	0.25
	Dichlorobromomethane	1	0.18	0.11
	Bromoform	62	8.5	1.7
	Methyl Bromide	3.9	8.7	5.2
	Carbon Tetrachloride	0.24	0.17	0.13
	Chlorobenzene	150	110	62
	Chloroethane	3	4.6	2.3
	Chloroform	0.24	0.16	0.084
	Methyl Chloride	1.2	1.5	1.1
	1,3-Dichloropropylene	0.7	0.4	0.48
	Chlorodibromomethane	1.1	0.13	0.08
	Ethyl benzene	230	1,300	1,100
	Hexachlorobutadiene	6.2	0.86	0.086
	Xylenes	210	1,400	730
	Methylene Chloride	8.9	4.3	4.1
	Naphthalene	56	6.2	3.1
	Tetrachloroethylene	5.7	1.1	3.3
	Toluene	520	720	400
	1,2-Trans-Dichloroethylene	63	120	73
	Trichloroethylene	2.8	1.6	1.1
	Vinyl Chloride	0.15	0.041	0.22
	Acrolein	0.1	0.042	0.021
	Acrylonitrile	0.21	0.039	0.028

Table 2
Laboratory Reporting Limits
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Reporting Limits		
		Soil (mg/kg)	Water (µg/L)	Air (µg/m³)
SW-846 8270C	Phenol	37,000	22,000	2,200
(SVOCs)	Bis(2-Chloroethyl)Ether	0.21	0.0098	0.0058
	2-Chlorophenol	63	30	18
	Bis(2-Chloroisopropyl)Ether	2.9	0.27	0.19
	N-Nitrosodi-n-Propylamine	0.069	0.0096	0.00096
	Hexachloroethane	35	4.8	0.48
	Nitrobenzene	20	3.4	2.1
	Isophorone	510	71	7.1
	2-Nitrophenol			
	2,4-Dimethylphenol	1,200	730	73
	Bis(2-Chloroethoxy)Methane			
	2,4-Dichlorophenol	180	110	11
	3-Methyl-4-Chlorophenol			
	2-Metyhlnaphthalene			
	Hexachlorocyclopentadiene	420	260	0.073
	2,4,6-Trichlorophenol	44	6.1	0.62
	2-Chloronaphthalene	3,900	490	290
	Dimethyl Phthalate	100,000	360,000	37,000
	2,6-Dinitrotoluene	0.72	0.099	0.0099
	4-Nitrophenol	490	290	29
	2,4-Dinitrotoluene	0.72	0.099	0.0099
	Diethyl Phthalate	49,000	29,000	2,900
	4-Chlorophenyl Phenyl Ether			
	2-Methyl-4,6-Dinitrophenol			
	N-Nitrosodiphenylamine	99	14	1.4
	4-Bromophenyl Phenyl Ether			
	Hexachlorobenzene	0.30	0.042	0.0042
	Pentachlorophenol	3.0	0.56	0.056

Table 2
Laboratory Reporting Limits
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Reporting Limits		
		Soil (mg/kg)	Water (µg/L)	Air (µg/m³)
SW-846 8270C (SVOCs- cont.)	Di-n-Butyl Phthalate	6,100	3,600	370
	Butylbenzyl Phthalate	12,000	7,300	730
	3,3'-Dichlorobenzidine	1.1	0.15	0.015
	Bis(2-Ethylhexyl)Phthalate	35	4.8	0.48
	Di-n-Octyl Phthalate	1,200	730	73
	Benzidine	0.0021	0.00029	0.000029
	2,4-Dinitrophenol	120	73	7.3
	N-Nitrosodimethylamine	0.0095	0.0013	0.00014
	1,2-Diphenylhydrazine	0.61	0.084	0.0087
SW-846 8310 (PAHs)	Acenaphthylene			
	Acenaphthene	3,700	370	220
	Fluorene	2,600	240	150
	Phenanthrene	22,000	1,800	1,100
	Anthracene	22,000	1,800	1,100
	Fluoranthene	2,300	1,500	150
	Pyrene	2,300	180	110
	Benzo(a)Anthracene	0.62	0.092	0.022
	Chrysene	6.1	9.2	2.2
	Benzo(b)Fluoranthene	0.62	0.092	0.022
	Benzo(k)Fluoranthene	6.2	0.92	0.22
	Benzo(a)Pyrene	0.062	0.0015	0.0022
	Indeno(1,2,3-cd)Pyrene	0.62	0.092	0.022
	Dibenzo(a,h)Anthracene	0.062	0.0092	0.0022
	Benzo(g,h,i)Perylene			
SW-846 8330 (Explosives)	HMX	3,100	1,800	180
	RDX	4.4	0.61	0.061
	1,3,5-Trinitrobenzene	1,800	1,100	110
	1,3-Dinitrobenzene	6.1	3.6	0.37
	Tetryl			
	Nitrobenzene	20	3.4	2.1
	2,4,6-Trinitrotoluene	16	2.2	0.22
	4-Amino-2,6-Dinitrotoluene			
	2-Amino-4,6-Dinitrotoluene			
	2,4-Dinitrotoluene	0.72	0.099	0.0099
	2,6-Dinitrotoluene	0.72	0.099	0.0099
	2-Nitrotoluene	370	61	37
	3-Nitrotoluene	370	61	37
	4-Nitrotoluene	370	61	37

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
EPA Method 300.0	Nitrate	N/A	100 ml	N/A	250 ml Plastic	N/A	4°C	N/A	48 Hours
EPA Method 365.4	Phosphorus	N/A	50 ml	N/A	125 ml Plastic	N/A	H_2SO_4, pH<2 4°C	N/A	28 Days
SW-846 Method 6010B (Metals (ICP))	Antimony Arsenic Barium Beryllium Cadmium Chromium (III) Copper Lead Nickel Selenium Silver Thallium Zinc	8 oz.	500 ml	2-4 oz. Soil Jar	1 Liter Plastic	4°C	HNO_3, pH<2 4°C	6 Months	6 Months
SW-846 Method 7196	Chromium (VI)	8 oz.	500 ml	2-4 oz. Soil Jar	1 Liter Plastic	4°C	4°C	24 Hours	24 Hours
SW-846 Method 7470A/7471A (Metals (ICP))	Mercury	8 oz.	500 ml	2-4 oz. Soil Jar	1 Liter Plastic	4°C	HNO_3, pH<2 4°C	28 Days	28 Days
SW-846 Modified Method 8015B (TPH-GRO)	Gasoline	8 oz.	3 5g samples	2-4 oz. Soil Jar	5g En Core sampler	4°C No Headspace	HCl, pH<2 4°C No Headspace	14 Days	14 Days

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
SW-846 Modified Method 8015B (TPH-DRO)	Mineral Spirits Gasoline Jet Fuel Karosene Diesel Fuel Fuel Oil Motor Oil TPH	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis
SW-846 Method 8081 (Pesticides)	4,4'-DDD 4,4'-DDE 4-4'-DDT Aldrin alpha-BHC beta-BHC Chlordane delta-BHC Dieldrin alpha-Endosulfan beta-Endosulfan Endosulfan Sulfate Endrin Endrin Aldehyde gamma-BHC Heptachlor Heptachlor Epoxide Toxaphene	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis
SW-846 Method 8082 (PCBs)	PCB-1016 PCB-1221 PCB-1232 PCB-1242 PCB-1248 PCB-1254 PCB-1260 Polychlorinated biphenyls	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
SW-846 Method 8260 (Volatile Organic Compounds)	1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethane 1,1-Dichloroethylene 1,2,4-Trichlorobenzenee 1,2-Dichlorobenzene 1,2-Dichloroethane 1,2-Dichloropropane 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2-Chloroethylvinyl Ether Benzene Dichlorobromomethane Bromoform Methyl Bromide Carbon Tetrachloride Chlorobenzene Chloroethane Chloroform Methyl Chloride 1,3-Dichloropropylene Chlorodibromomethane Ethyl benzene Hexachlorobutadiene Xylenes Methylene Chloride Naphthalene Tetrachloroethylene Toluene	8 oz.	3-5g samples	2-4 oz. Soil Jar	5g En Core sampler	4°C No Headspace	HCl, pH<2 4°C No Headspace	14 Days	14 Days

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
SW-846 Method 8260 (Volatile Organic Compounds) (cont.)	1,2-Trans-Dichloroethylene Trichloroethylene Vinyl Chloride Acrolein Acrylonitrile	8oz.	3 VOA Vials	2-4 oz. Soil Jar	40 ml VOA Vial	4°C No Headspace	HCl, pH<2 4°C No Headspace	14 Days	14 Days
SW-846 Method 8270 (Semi-volatile Organic Compounds)	Phenol Bis(2-Chloroethyl)Ether 2-Chlorophenol Bis(2-Chloroisopropyl)Ether N-Nitrosodi-n-Propylamine Hexachloroethane Nitrobenzene Isophorone 2-Nitrophenol 2,4-Dimethylphenol Bis(2-Chloroethoxy)Methane 2,4-Dichlorophenol 3-Methyl-4-Chlorophenol 2-Metyhlnaphthalene Hexachlorocyclopentadiene 2,4,6-Trichlorophenol 2-Chloronaphthalene Dimethyl Phthalate Acenaphthylene 2,6-Dinitrotoluene Acenaphthene 4-Nitrophenol 2,4-Dinitrotoluene Diethyl Phthalate	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton- 40 Days to Analysis	7 Days to Extracton- 40 Days to Analysis

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
SW-846 Method 8270 (Semi-volatile Organic Compounds-cont)	4-Chlorophenyl Phenyl Ether Fluorene 2-Methyl-4,6-Dinitrophenol N-Nitrosodiphenylamine 4-Bromophenyl Phenyl Ether Hexachlorobenzene Pentachlorophenol Phenanthrene Anthracene Di-n-Butyl Phthalate Fluoranthene Pyrene Butylbenzyl Phthalate 3,3'-Dichlorobenzidine Benzo(a)Anthracene Chrysene Bis(2-Ethylhexyl)Phthalate Di-n-Octyl Phthalate Benzo(b)Fluoranthene Benzo(k)Fluoranthene Benzo(a)Pyrene Indeno(1,2,3-cd)Pyrene Dibenzo(ah)Anthracene Benzo(ghi)Perylene Benzidine 2,4-Dinitrophenol N-Nitrosodimethylamine 1,2-Diphenylhydrazine	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis

Table 3
Container, Preservation, and Holding Time Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Method	Parameter	Minimum Sample Size		Container		Sample Preservation		Holding Time	
		Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water	Soil/ Waste	Water
SW-846 Method 8310 (PAHs)	Acenaphthylene Acenaphthene Fluorene Phenanthrene Anthracene Fluoranthene Pyrene Benzo(a)Anthracene Chrysene Benzo(b)Fluoranthene Benzo(k)Fluoranthene Benzo(a)Pyrene Indeno(1,2,3-cd)Pyrene Dibenzo(a,h)Anthracene Benzo(g,h,i)Perylene	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis
SW-846 Method 8330 (Explosives)	HMX RDX 1,3,5-Trinitrobenzene 1,3-Dinitrobenzene Tetryl Nitrobenzene 2,4,6-Trinitrotoluene 4-Amino-2,6-Dinitrotoluene 2-Amino-4,6-Dinitrotoluene 2,4-Dinitrotoluene 2,6-Dinitrotoluene 2-Nitrotoluene 3-Nitrotoluene 4-Nitrotoluene	8 oz.	1 Liter	2-4 oz. Soil Jar	2-1 Liter Glass Amber	4°C	4°C	14 Days to Extracton-40 Days to Analysis	7 Days to Extracton-40 Days to Analysis

Table 4

Summary of Analytical Data Deliverable Requirements
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

Requirements for all methods:	
- Holding time information and methods requested	Signed chain-of-custody forms
- Discussion of laboratory analysis, including any laboratory problems	Case narratives
Organics: GC/MS analysis	
- Sample results, including TICs	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- GC/MS tune	CLP Form 5 or equivalent
- GC/MS initial calibration data	CLP Form 6 or equivalent
- GC/MS continuing calibration data	CLP Form 7 or equivalent
- GC/MS internal standard area data	CLP Form 8 or equivalent
Organics: GC analysis	
- Sample results	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- Initial calibration data	CLP Form 6 or equivalent
- If calibration factors are used	A form listing each analyte, the concentration of each standard, the relative calibration factor, the mean calibration factor, and %RSD
- Calibration curve if used	Calibration curve and correlation coefficient
- Continuing calibration data	CLP Form 9 or equivalent
- Positive identification (second column confirmation)	CLP Form 10 or equivalent
Metals	
- Sample results	CLP Form 1 or equivalent
- Initial and continuing calibration	CLP Form 2 or equivalent, dates of analyses and calibration curve, and the correlation coefficient factor
- Method blank	CLP Form 3 or equivalent and dates of analyses
- ICP interference check sample	CLP Form 4 or equivalent and dates of analyses
- Spike sample recovery	CLP Form 5A or equivalent
- Postdigestion spike sample recovery for ICP metals	CLP Form 5B or equivalent

- Postdigestion spike for GFAA	CLP Form 5B or equivalent
- Duplicates	CLP Form 6 or equivalent
- LCS	CLP Form 7 or equivalent that includes acceptable range or window
- Standard additions (when implemented)	CLP Form 8 or equivalent
- Holding times	CLP Form 13 or equivalent
- Run log	CLP Form 14 or equivalent
Wet Chemistry	
- Sample results	Report result
- Matrix spike recovery	%Recovery
- Matrix spike duplicate or duplicate	%Recovery and %RPD
- Method blank	Report results
- Initial calibration	Calibration curve and correlation coefficient
- Continuing calibration check	Recovery and % difference
- LCS	LCS result and control criteria
- Run log	Copy of run log

Laboratory SOP's will be defined once a contract laboratory(s) has been selected.

File Format for Electronic Deliverables
St. Louis Army Ammunition Plant
URS Project No. 49F0K96219.01

EDD's provided by the laboratory should be comma separated value (*.csv) formatted text files. For fields which contain a comma, the field will be enclosed in double quotation marks (e.g."1,1-Dichlorobenzene"). The files should contain a placeholder for each of the following fields and should not have any rows containing field names.

	Field	Description	Required
1.	SITE	Contains the site name where the sample was taken. Leave field blank Max. Length - 30	
2.	LOCATION	Contains the location name where the sample was taken. Leave field blank Max. Length - 30	
3.	LABNAME	Name of the lab doing the sample analysis. Examples: EMAX Max. Length - 30	X
4.	SDG	Sample delivery group or lab batch ID associated with the sample. Examples: 1234-09, SDG120004 Max. Length - 20	X
5.	FIELDID	URS chain of custody sample ID. URS ID for all field samples, append "MS" or "MSD" to the end of URS ID for matrix spike and matrix spike duplicate. Do the same to lab ID for other lab QA samples. Max. Length - 50	X
6.	EPASAMPLEID	EPA sample ID (if applicable) Max. Length - 30	
7.	QAQCTYPE	Type QAQC (blank if none). Examples: MS, MSD, DQC, RIN Max. Length - 20	X
8.	MATRIX	Matrix of sample. Examples: AQUEOUS, SOIL, SOLID Max. Length - 20	X
9.	LABSAMPLEID	Lab sample ID. Max. Length - 30	X
10.	METHOD	Analysis method name/number. Examples: SW846-8330, SW846-8260B Max. Length - 50	X
11.	SAMPLEDATE	Date the sample was taken. Examples: 01/01/1983, 12/12/1992, 06/15/1999 Format : mm/dd/yyyy	X

Field		Description	Required
12.	RECEIVEDATE	Date the sample was received by the lab. Format : mm/dd/yyyy	X
13.	EXTRACTDATE	Date the sample was extracted/prepared by the lab (if applicable) Format : mm/dd/yyyy	
14.	ANALYSISDATE	Date the sample was analyzed. Format : mm/dd/yyyy	X
15.	PREPLEVEL	Preparation level of the sample. Leave field blank Max. Length - 10	
16.	COLORBEFORE	Color of the sample before analysis Leave field blank Max. Length - 10	
17.	COLORAFTER	Color of the sample after analysis Leave field blank Max. Length - 10	
18.	CLARITYBEFORE	Clarity of the sample before analysis Leave field blank Max. Length - 10	
19.	CLARITYAFTER	Clarity of the sample after analysis Leave field blank Max. Length - 10	
20	TEXTURE	Texture of the sample. Leave field blank Max. Length - 10	
21.	PERCENT SOLIDS	Percent solids or percent moisture of the sample (if applicable).	
22.	TEST	Internal test name/method used in the lab (if available). Max. Length - 50	
23.	TESTVERSION	Run number of the test or method Max. Length - 10	
24.	CAS	CAS number associated with the chemical analyte (if applicable). Max. Length - 15	
25.	ANALYTE	Name of the chemical analyte. Max. Length - 50	X
26.	RESULT	Numeric result of the chemical analyte. Leave blank for non-detect results.	X
27.	ERROR	Error of the chemical analyte (radionuclide only).	X
28.	UNITS	Units of measure. Examples: MG/L, UG/M3, ug/L Max. Length - 10	X
29.	DILUTION	Dilution used for chemical analyte analysis. Examples: 1.0, 5.0	X

	Field	Description	Required
30.	DETECTLIMIT	Detection limit of the chemical analyte (if available). PQL not MDL	X
31.	DLQUALIFIER	Detection or report qualifier. Examples: U, ND - Use "U" for non-detected and blank for other. Max. Length - 15	X
32.	LABQUALIFIER	Lab qualifier. All qualifiers except "U" Max. Length - 10	X
33.	SURROGATE	If the chemical analyte is a surrogate. Format: Y or blank Max. Length - 1	X
34.	COMMENTS	Any comments associated with the chemical analyte analysis. Max. Length - 240	